THE HOPE REPORTS

VOL. VIII

1910—1913

WITH A SEPARATE APPENDIX

EDITED BY

EDWARD B. POULTON, D.Sc., M.A.

Hon. LL.D. Princeton, Hon. D.Sc. Dunelm., F.R.S., etc.

HOPE PROFESSOR OF ZOOLOGY IN THE UNIVERSITY OF OXFORD
FELLOW OF JESUS COLLEGE, OXFORD
PRESIDENT OF THE LINNEAN SOCIETY OF LONDON
MEMBRE HONORAIRE DE LA SOCIÉTÉ ENTOMOLOGIQUE DE BELGIQUE
SOCIO HONORÁRIO DE LA REAL SOCIEDAD ESPAÑOLA DE HISTORIA NATURAL
CORRESPONDENT OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA
HONORARY MEMBER OF THE ACADEMY OF SCIENCE, NEW YORK
CORRESPONDING MEMBER OF THE SOCIETY OF NATURAL HISTORY, BOSTON, AND
THE AMERICAN ENTOMOLOGICAL SOCIETY

OXFORD
PRINTED FOR PRIVATE CIRCULATION
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1913

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ALFD. ROBINSON, DEL.

THE MAKERS OF THE HOPE DEPARTMENT
OXFORD UNIVERSITY MUSEUM

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PREFACE

The preceding volume of Hope Reports, the seventh, was issued more than three years ago, in the summer of 1910, the preface being dated June 20. The unusual length of this interval is mainly due to the time occupied in rearranging the collections in consequence of the transference of a large part of them to the southern half of the old Radcliffe Library, and in preparing for the Second International Entomological Congress, held at Oxford in August 1912. Much extra work was also caused by the long and painful illness and lamented death of Mr. R. Shelford, the late Assistant Curator, and by difficulties of various kinds which prevented his successor, Mr. R. S. Bagnall, from beginning regular work here until June of the present year.

The forty-nine octavo papers now accumulated fill two volumes of a rather more convenient size and weight than VI and VII. Nine other memoirs of a much larger size are bound together separately, forming an Appendix to the present volume. Ten papers specially concerned with the African fauna occupy Volume IX, while the thirty-nine here collected, as well as the nine in the Appendix, deal with the most varied subjects. The memoirs in the Appendix, being of an unusual size, have appeared gradually during a number of years, and I have even included a single paper published in 1890. In the present volume, on the other hand, all except two of the papers were published in the years 1910–1913.

The first paper is a brief account of the life and work of Robert Shelford, to whom the Hope Department and the Sarawak Museum owe so much. Far stronger testimony is borne by the record of his own fine researches issued in this volume (14, 17–21) and its Appendix (1–7). I have referred, in (1) p. 3, to (14)—'Mimicry amongst the Blattidae'—as the research which probably interested him more than any other of his long series of investigations on the Orthoptera. 'It is a pathetic circumstance that the

publication of the paper was nearly coincident with its author's death.' Memoirs 17–21 are a continuation of the work on the Systematics of the Blattidae which made him the leading authority on the group. The appearance of the separate appendix is almost entirely due to his efforts; for out of its nine memoirs he contributed seven, all of them upon his favourite Blattidae. I well remember, when he was writing his account of the subfamilies (Appendix 1–5) for Wytsman's 'Genera Insectorum', how pleased he was at the thought that they would appear at some future time in a large 4to volume of Reports devoted to the Systematics of the Orthoptera. The dream was not destined to be fulfilled except as regard the first five subfamilies of the Blattidae. What might have been may be realized by studying these admirable monographs.

The papers on bionomics are headed by (3)—Dr. Dixey's second Presidential address to the Entomological Society —'Entomology and Evolution.' In 1908 Mr. Guy A. K. Marshall published a criticism of Diaposematism or Reciprocal Mimicry. For some years I have kept this paper, hoping for the time to write a reply to some of the arguments contained in it, but lately I have come to the conclusion that for the present it is best to concentrate attention on the accumulation of facts bearing on the discussion. As it is impossible to know when I shall be able to write on the subject, Mr. Marshall's paper is included, as (4), in the present volume. Dr. Dixey's reply in the Transactions of the Entomological Society (1908, p. 559) ought to have followed (4), but some of the copies have been mislaid and the appearance of the paper in a volume of Hope Reports is therefore unfortunately postponed. A brief statement on the same subject by Dr. Dixey appears in (5), under which number references to the account of the discussion printed in Vol. VII of the Hope Reports will be found in the Contents.

Mr. R. I. Pocock's important experiments, conducted in the Zoological Gardens, on the palatability of British insects (6), three papers (7–9) on the evolutionary significance of the study of Mimicry by the Professor, Colonel Manders's temperature experiments and criticisms of the theories of Mimicry (10), Mr. J. C. Moulton's evidence in favour of the same theories (11), Miss Bridges's experiments on the colours of certain British larvae and pupae (12), Dr. Perkins's account of the colour-groups of the Hawaiian wasps (13), the late Mr. R. Shelford's paper (14) on Mimicry in the Blattidae, already referred to, together with suggestions as to the meaning of the strange shapes of the Membracidae by the Professor, (9) in the Appendix, complete the series of separate papers on bionomic questions, although the great majority of the communications published in the Proceedings of the Entomological Society in 1910 (34), 1911 (35), and 1912 (36) deal with similar subjects. The long series of notes and brief papers in (35) and (36) will give some idea of the varied work of the Hope Department and of its close relations with naturalists resident in the tropics, especially of Africa. A complete list of titles will be found on pages 10–16 of the Contents, under (35) and (36). Among those who have helped to bring together this fine body of records I must specially mention my friends in Africa—Dr. G. D. H. Carpenter, Mr. J. A. de Gaye, Mr. W. A. Lamborn, Mr. G. F. Leigh, Mr. S. A. Neave, Rev. K. St. Aubyn Rogers, Mr. C. F. M. Swynnerton, and Mr. C. A. Wiggins, D.P.M.O. of the Uganda Protectorate; in Borneo—Mr. J. C. Moulton; in the Sandwich Islands—Dr. R. C. L. Perkins; in Ceylon—Mr. E. E. Green; in India—Mr. T. Bainbrigge Fletcher; and among those at home—Dr. F. A. Dixey, Mr. H. Eltringham, Dr. G. B. Longstaff, Mr. Roland Trimen, and Commander J. J. Walker.

The papers on Systematics include (16) the third of the

valuable series on the Tetriginae (Orthoptera) of the Hope Department, by Dr. J. L. Hancock, the description of a new moth from New Zealand (15) by Mr. E. Meyrick, as well as the late Mr. R. Shelford's papers in this volume and its Appendix, already referred to. Notes on the moths of the 'Dale Collection' (22) are contributed by Commander J. J. Walker, and on the Orthoptera (23) by Mr. W. J. Lucas. A third supplement to the beetles of the Oxford district (24) has been written by Commander Walker, and notes on the life-histories of two British beetles (25) by Mr. A. H. Hamm, and of another by Mr. Joseph Collins (26).

It is a pleasure to include for the first time a series of papers (27–33) by Mr. R. S. Bagnall on the difficult groups he has done so much to elucidate—the Thysanoptera (Thrips) and the Myriopoda.

The progress of the Hope Department in 1910, 1911, and 1912 may be traced in the Annual Reports (37–39).

All the nine memoirs in the separate Appendix have been mentioned above except (8), a paper on the external structure of the Lepidopterous pupa published by the Professor in 1890. It so happened that the remaining separata were just sufficient to supply the issue, and it was thought that they might be usefully employed in this way. At the same time it may not be out of place to inform readers who are interested that the subject was continued in another paper of which separata are not available. This second paper, containing parts IV–V, was published, like the first, in the Transactions of the Linnean Society. (Vol. V, Pt. 7, 1891, p. 245.)

EDWARD B. POULTON.

Hope Department of Zoology,
University Museum, Oxford,
July 21, 1913.

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OBITUARY.

R. W. C. SHELFORD.

ZOOLOGISTS have heard with great regret of the death, on June 22nd, of Robert Walter Campbell Shelford, the leading authority on the *Blattidæ*, and a naturalist of very broad interests.

Shelford was born at Singapore on Aug. 3rd, 1872—the son of a merchant who was a member of the Legislative Council, and made C.M.G. in recognition of his many public services. There is no evidence that Shelford's taste for natural history was inherited, and it did not appear in any other member of the family. Prevented from taking a part in the games and ordinary outdoor pursuits of a boy and a young man, his active mind turned to observation, and he became a naturalist. He was educated privately until he entered King's College, London, and later Emmanuel College, Cambridge. At Cambridge, where he took a second in both parts of the Natural Science Tripos, he received a solid foundation for the excellent zoological work of his mature years.

After taking his degree he became, in 1895, a Demonstrator in Biology, under Professor L. C. Miall, at the Yorkshire College, Leeds. In 1897 he went to Borneo as Curator of the Sarawak Museum, established by Rajah Brooke at Kuching. During his seven years' tenure of this position he availed himself to the full of the many opportunities for studying the animal life of the tropics, and of making observations in anthropology, a subject which always strongly attracted him. His fruitful labours in the increase and arrangement of the Sarawak Museum naturally led him to take a wide survey of the animal kingdom, and he soon began the study of Mimicry, which unites under one point of view the insects of many diverse groups and their vertebrate enemies. He found Borneo a very rich and imperfectly explored field for the study of this subject, and before long he entered into a regular correspondence with me, sending large consignments of mimetic insects for investigation and determination. The result of this work was the appearance of his important paper in the 'Proceedings' of the Zoological Society for 1902 (p. 230). This interesting monograph is illustrated by five coloured plates showing Bornean mimetic insects of the most varied groups. The outcome of the correspondence was his desire to work in the Hope Department when his seven years in Borneo came to an end in 1905. Towards the close of this period he wrote to me saying that if it was

impossible to provide a salary he must really come without one. Fortunately, at this moment, Magdalen College began to place an annual grant at the disposal of the University for the provision of extra assistance in the departments, and it thus became possible to appoint an assistant-curatorship, with a small income, augmented later on from the Common University Fund. Shelford accepted this position, and entered into residence at Oxford in the autumn term of 1905. After leaving Kuching, and before returning home by way of Japan, Vancouver, and the United States, he spent several months travelling in the Malay Archipelago. On June 25th, 1908, he married Audrey Gurney, daughter of the Rev. Alfred Richardson, vicar of Combe Down, Bath.

Until his long illness, which began in April, 1909, Shelford's work in Oxford was continued uninterruptedly and with the greatest energy. He at once undertook the study of the large collection of Orthoptera in the Hope Department, beginning with the *Blattidæ*, which he brought into a highly efficient state. In the course of his work upon this group he determined and described, in a long series of valuable memoirs, the new species in all the great Continental collections, with the result that the Hope Department now contains by far the finest collection of *Blattidæ* in the world, and includes types or co-types of a large proportion of all the known species. He had also begun to work at the other Orthopterous groups, especially the *Phasmidæ* and *Mantidæ*, and, through his influence, the *Tetriginæ* (*Acridiidæ*) were worked out by Dr. J. L. Hancock, of Chicago, and *Gryllacris* by Dr. Achille Griffini, of Genoa. He was an indefatigable worker, as will be realized by any naturalist who sees what the Oxford collection of *Blattidæ* became after only four years' work. A too brief respite in the course of his illness enabled him to return for a time and carry on the old work, and, up to the end of 1911, he was still able to help the Department in many ways, and also to begin a Natural History of Borneo. It is very much to be hoped that this work, though incomplete, may be published at no distant date. It is sure to be full of observations of the greatest interest to naturalists of all kinds.

When three years old Shelford contracted tubercular disease of the hip-joint, as a result of a fall downstairs, and was condemned to spend many years on his back. A severe operation was performed when he was ten, and at thirteen he was able to leave home and reside with a tutor. He was left with a stiff joint, and from time to time suffered greatly from sciatica. During his residence in Sarawak

a fall from a rickshaw produced an abscess, from which he entirely recovered. During four years in Oxford his leg seemed to give him no trouble except for attacks of sciatica, to which he never gave in and, in spite of his lameness, he used to find great enjoyment in playing golf. An accidental slip led to the recrudescence of the old disease, and to the terrible suffering of his last illness.

Of all the memoirs which he wrote, Shelford was, I think, most interested in that "On Mimicry amongst the *Blattidæ*"*—a subject upon which he had reflected and had been accumulating material for some years. It is a pathetic circumstance that the publication of the paper was nearly coincident with its author's death. I shall ever retain grateful memories of pleasant years spent in hard work and constant friendly intercourse, while his efficient control of the Museum and bright, attractive, many-sided personality will be long remembered in Sarawak.

EDWARD B. POULTON.

Hope Department, Oxford University Museum.

* Proc. Zoc. Soc. Lond. 1912, p. 358.

THE PRESIDENT'S ADDRESS.

LADIES AND GENTLEMEN,

OUR Anniversary Meeting last year took place in the midst of a General Election. We may be permitted to hope that these political tournaments are not about to become as regularly annual as our own celebration, but the fact remains that this year we have only escaped a similar coincidence by the space of a few weeks. Our feelings with regard to the recent contest are probably mixed; but I am on safe ground in asserting that we one and all regret that the House of Commons has lost, even if only for a time, the services of a distinguished representative of Entomology.

The year just finished has been an eventful one. It has been marked by the passing of a beloved Sovereign, who, during his all too short reign, more than fulfilled the hopeful anticipations with which his accession was greeted. In his Successor we welcome a Ruler who has already given evidence of the solicitude with which he watches over the best interests of his people, and who inspires us with confidence that in him the cause of science and learning will find an earnest advocate and promoter. In this he will but be following the tradition set by an illustrious Father and Grandfather, whose example is destined to bear fruit for many years to come.

It will be within the recollection of all the Fellows of this Society that loyal Addresses were presented on their behalf to King George on his Accession, and to the widowed Queen Alexandra. The text of these Addresses, together with that of the Royal Reply, is to be found in our Proceedings.

At a time of general mourning it was obviously fitting that we should defer the holding of our proposed Conversazione.

It was eventually decided to forego this entertainment altogether for the year just ended; and we may hope that the social and scientific gathering, when it does take place, may be for entomologists not the least interesting and brilliant of the functions marking the season of the coming Coronation.

If the public bereavement has been severe, our private losses have also been heavy. All who had the privilege of knowing EDWARD SAUNDERS will preserve an abiding memory of his striking, semi-ascetic countenance, his unfailing courtesy, his quiet, unassuming but forceful character, his deep learning, and the *mitis sapientia* that pervaded in him both word and action. One who has a much better right than myself to speak of our departed friend has written an eloquent and touching tribute to his memory; and those of our number who would wish to gain an idea of what manner of man Edward Saunders was, should turn to the account of his life by the Rev. F. D. Morice. As a Fellow of the Royal Society he worthily upheld the dignity of Entomology among the Sciences of Life; and his loss has been keenly felt, not only by his immediate associates, but throughout all entomological circles at home and abroad.

His death was shortly followed by that of his brother, GEORGE SHARP SAUNDERS, F.L.S., also a keen entomologist, and one who had made valuable contributions to our knowledge of noxious insects.

It was with unusually great regret that we received the news of the untimely death of GEORGE WILLIS KIRKALDY, which took place at San Francisco, in the thirty-seventh year of his age. It was some five or six years ago that he met with the accident, while riding, from the ultimate effects of which he died. Educated at the City of London School, he early developed a taste for entomology. His first paper, "A Revision of the Notonectidae," was published in 1897. The hemipterous portion of the Zoological material collected by Dr. R. C. L. Perkins was worked out by him, and the results published in 1903 as part of the "Fauna Hawaiiensis." In the same year Mr. Kirkaldy was appointed Assistant-Entomologist to the Hawaiian Territorial Board of Agricul-

ture and the Hawaiian Sugar Planters' Association, this office giving him the opportunity of continuing his studies on the Hemiptera, and especially on the Fulgoridae. His "Catalogue of the Hemiptera," which was to have included the whole Order, has been published in part, and it is understood that further instalments will be issued under the auspices of M. J. R. de la Torre Bueno, to whose charge Kirkaldy's unpublished manuscripts and notes have been committed. Mr. F. W. Terry, to whom I am indebted for many of the details just given, has written as follows of his deceased associate: "A voluminous writer and wide reader, a staunch friend and genial companion, he was always ready to give others the benefit of his wide bibliographical knowledge. His optimistic and kindly personality will be greatly missed by his friends and colleagues."

George Carter Bignell, known for his earlier work on Lepidoptera and his later researches on various forms of parasites, especially those infesting the Aphides, died early in the year at the ripe age of eighty-four.

Other losses have been suffered by our Society in the deaths of Albert Piffard, a well-known traveller, whose entomological interests were chiefly engaged in the collection and study of Coleoptera and Diptera; and in those of Oliver C. Goldthwait, George Henry, and W. A. Luff.

But unfortunately the death-roll of 1910 does not exhaust the list of our losses. Within the last few days we have received the sad intelligence that James William Tutt, a member of our Council and President-nominate, is no more. This is not the time or the place to attempt a full appreciation of his personal qualities, or of the services which he has rendered to entomology in general and to our own Society in particular. But I may at least be permitted to recall his untiring industry, his exemplary thoroughness, his contagious enthusiasm, and that over-mastering love of his subject which constrained him to devote the scanty leisure of a busy professional life to the single-minded pursuit of his entomological studies. To what good purpose he used his opportunities we all know; and those of us who have had occasion to serve with him on the Council and Publications Committee will be

especially sensible of what his loss means to the Society in its business relations. He has deserved well of us, and his place will not easily be filled.

Outside our own ranks the year has witnessed the decease of the well-known collector H. McArthur, who by his labours in Central Asia, Kashmir and India, as well as nearer home in the Orkneys, Shetlands and Hebrides, has widened the bounds of entomological knowledge.

The death of Gustav Breddin, which took place during the last days of 1909, should not be allowed to pass without notice. A recognised authority on the Hemiptera, he was distinguished by the specially scientific character of his work upon the group.

Lastly must be mentioned the death of Gustav Fischer, the well-known publisher of Jena. Not specially an entomologist, he has yet deserved well of the entomological fraternity on account of the numerous works, of high interest to all students of insects, which under his auspices have seen the light.

In the course of the year several of our Fellows have been the recipients of well-merited honours. It is a matter of great satisfaction to us all that the deserts of my immediate predecessor in this Chair have met with recognition in the highest quarters. As a Companion of the Imperial Service Order, Mr. C. O. Waterhouse will carry into his retirement from the public service the affectionate goodwill of all who know him; and we may hope in this Society to enjoy the benefit of his long experience and matured wisdom for many years to come. The University of Oxford conferred distinction at once on itself and on our ex-President Professor Meldola, F.R.S., by bestowing on him the honorary degree of Doctor in Science, and by appointing him Herbert Spencer Lecturer for 1910. Mr. Selwyn Image, a member of our Council, has been elected to the Slade Professorship of Fine Art in the same University. Those who, like myself, have sat at the feet of John Ruskin, will agree that no more worthy occupant could have been found for the Chair that will ever be linked in association with the memory of that great teacher and prophet. With

Ruskin, nature and art, though not identical, were inseparable; and in his successor to-day we find a happy illustration of that successor's favourite maxim, "Ars est homo additus naturae." We may congratulate ourselves that the artistic skill of our Slade Professor, already exemplified in the Addresses which his handicraft has helped to make worthy at once of the Society and of their recipients, will leave with us a permanent memorial in the shape of our new seal, in truth a *κτῆμα ἐς ἀεί* for us and our successors.

This leads me to speak more particularly of the occasion of one of the Addresses to which I have just alluded. At the Anniversary Meeting of the Royal Society, the Darwin Medal was presented to our valued Fellow and ex-President, Mr. Roland Trimen, M.A., F.R.S. The event was felt to be a subject of special congratulation to entomological interests in general as well as to the recipient in particular. It will be remembered that the Society passed unanimously a special resolution asking the officers to convey to Mr. Trimen "the hearty congratulations of the Society on the occasion of the award to him of the Royal Society's Darwin Medal." I think it will be of interest to put on record the terms of the Address, or rather Letter, in which this was done, and also Mr. Trimen's reply. The Address, after quoting the Resolution, proceeds as follows :—

"In conveying to you this expression of the Entomological Society's appreciation of the honour conferred on a distinguished ex-President, we should wish to add that, in our opinion, this event reflects no less honour upon the donors than upon the recipient of the Medal. You are known to all generations of scientific men as a veteran worker among those who have found their chief inspiration in the principles laid down by Charles Darwin. Among living naturalists there are few indeed whose merits as associates and fellow-workers with Darwin can bear comparison with your own; and we feel sure that all alike, in rejoicing at this public recognition of your life-long services to Biological science, will agree that the present honour could not have been more worthily bestowed."

The letter was signed, on behalf of the Society, by the President and Secretaries. Mr. Trimen's reply was as follows:—

"*Southbury, Guildford,*
"*December* 19*th*, 1910.

"To the ENTOMOLOGICAL SOCIETY OF LONDON.

"It is difficult to give adequate expression to my grateful sense of the honour done me by the Resolution of the Entomological Society of London, according its hearty congratulations on the recent award to me of the Darwin Medal of the Royal Society, and by the highly appreciative and cordial terms of the letter of the President and Secretaries transmitting that Resolution.

"Such commendation from a Learned Society with which I have been associated for over fifty years is no slight one, and greatly enhances the distinction of the Medal in question. I cannot say how much I owe to the kindness and encouragement I have always met with from the Society collectively and from so many individual members of it, and I recognise that the Medal is as much due to the countenance and aid thus generously given me as to any efforts of my own.

"I find pleasure in thinking that Mr. Darwin himself would have approved of the award this year to an entomologist whom he knew, and who had the happiness of rendering him some slight aid in his researches. For was not that greatest of naturalists' first love *beetles*?—and has he not himself recorded that his favourite toast at Cambridge was '*Floreat Entomologia!*'? All of us heartily re-echo this aspiration, and it might well be adopted as the motto of our Society.

"Your faithful and attached Colleague,
"ROLAND TRIMEN."

Another great naturalist, whom we may claim as an Honorary Fellow of our Society, is the veteran French entomologist, J. H. Fabre, of Sérignan, Vaucluse, whose eightieth birthday was signalised by a festival held in his honour at Orange, on the 3rd of April. The committee formed to promote this object contained some of the names most

illustrious in the Science and Literature of France; nor were our own countrymen forgotten. A presentation was made to the hero of the day, including a fine plaquette, a duplicate copy of which I had the pleasure of exhibiting lately in this room. Several Fellows of our Society contributed towards the fund raised for the occasion, and I cannot resist quoting a few words from the letter of acknowledgment written by Dr. Legros, the Secretary of the movement:—

"Je vous prie, Monsieur le Président, de recevoir pour vous-même et de vouloir bien transmettre aux généreux donateurs l'expression de la profonde gratitude des organisateurs du comité. La noble Angleterre vient de nous donner une preuve de plus de ses traditions de courtoisie et de solidarité."

This, I think, may be taken as something more than mere conventional politeness. I prefer to see in it evidence of what I am convinced is a fact, viz. that nothing is more apt to promote feelings of international goodwill than community of scientific interests.

If we wished for another indication of the truth of this opinion, we should find it in the excellent and interesting account of the Jubilee of the Entomological Society of Russia, furnished to our Proceedings by Dr. Malcolm Burr, who so worthily represented us on that occasion.

Our representatives at the Zoological Congress at Graz were the Hon. W. Rothschild and Dr. Karl Jordan. The entomologists there present were few, but made up in quality what they lacked in number. Many of our Society will be pleased to know that the long-continued experimental work of Professor Max Standfuss was recognised at the Congress by the bestowal on him of a special honour.

But if entomologists at Graz were few and far between, they had mustered in good force at Brussels for the First International Congress of Entomology. The success of this undertaking was undoubted. The social and scientific aspects of the Congress were both felt to be of high value; and the fact that Brussels was *en fête* over the Exhibition with a gaiety not yet sobered by the deplorable conflagration, while it may have led here and there to a little crowding and inconvenience, yet provided ample compensation, especially for the

younger and more sportive spirits amongst us. The Entomological Society has every reason to be satisfied with the part played by its Fellows at the Congress. Not only Messrs. Trimen, Merrifield and Donisthorpe, who, with your President, were specially deputed as representatives, but Professor Poulton, Professor Punnett, Hon. C. and Hon. W. Rothschild, Dr. Karl Jordan, Dr. Burr, and others too numerous to mention, were prominent in the proceedings. Brussels has given a good lead, which we may feel confident will be well followed up in this country next year under the auspices of Professor Poulton. When the International Congress has become an established and venerable institution, I trust it will not be forgotten that the impulse which set it going originated from Tring.

While on the subject of the Congress I recall with pleasure the fact that a most agreeable feature was supplied by the appearance, during its progress, of Mr. Eltringham's splendid work on Mimicry in African Butterflies, a book which I cordially commend to the notice of all those who are in any way interested in the subject of mimicry.

Before turning to the more special portion of my Address, it now only remains for me to express my very grateful thanks to the Society in general, and to the Business and Publications Committee, the Council, and the Officers, in particular, for the pleasant term of office which I have enjoyed. The experience of another year in the Chair which my predecessor found materially, though I trust not morally, uncomfortable, has only served to deepen my former impression of the magnitude of the obligation which the Society owes to its Librarian, its Treasurer and its Secretaries. To repeat what I have said on a former occasion is unnecessary, but I cannot allow this opportunity to pass without adding a word of personal appreciation of the services of our retiring Honorary Secretary, Mr. H. Rowland-Brown. I count myself fortunate to have had the benefit of his assistance and advice, not only during my raw novitiate, but up to the end of my tenure of office. As the last of a long succession of Presidents whom he has helped to bring up in the way they should go, I congratulate him on his well-earned retirement, from which I venture to hope

he will one day emerge into an official position which he has not yet held, but which he, if any one, is fully competent to fill.

Entomology and Evolution.

In my former Presidential Address I took as a subject a matter of special morphological interest. On the present occasion I propose to ask your attention to a topic of somewhat wider scope. It is not often that the opportunity arises of dealing in a general way with the methods and objects of entomological science. Such treatment is rightly considered to lie outside the proper range of our Transactions, nor would it be more in place in the record of our less formal discussions, or in the midst of those discussions themselves. But a Presidential Address affords a legitimate occasion for such generalities. It is possible there, without impertinence or irrelevance, to give expression to personal views of a larger application than to any one department of our subject, or to any particular example of the advancement of entomological knowledge. I wish, then, to devote a little time to a brief consideration of some of the matters with which we entomologists are brought into contact, in their bearing on biological science in general; and incidentally to notice the relation which obtains, or should obtain, between different sides of entomological study.

With the recent Darwin celebrations still so fresh in our recollection, it is scarcely necessary to remind ourselves that most biological pursuits derive their main interest and importance from the light they are able to throw on the process of organic evolution. This is perhaps especially the case with entomology. The intrinsic interest of the study is great, and has been so felt by many lovers of nature in days before Darwin. But it needed the Darwinian touch to transform the dry bones of description and classification into a living and breathing organism. Under the stimulating influence of the theory of selection, all the scattered items of entomological knowledge were found to have their proper place and significance in relation to the whole structure, and every addition to our store of entomological fact was welcomed as marking a

fresh stage of growth in our comprehension of at least one portion of the evolutionary domain. And the peculiar value of entomological data for research on Darwinian lines was speedily recognised. The material with which we entomologists have to deal is for the most part abundant, of manageable size, easy of manipulation, and favourably constituted for experiment. Hence it has followed that many of the most important steps in the progress of our evolutionary knowledge have depended directly or indirectly on the study of insects.

Let me take as an example the present state of scientific opinion with regard to the transmission of acquired characters, or, as some prefer to put it, the inheritance of somatic modifications. It is hardly necessary for me to say that neo-Lamarckians are still on the look-out for an instance of such transmission, and that neither among insects nor anywhere else have they been able to find one. The antecedent improbability of the alleged phenomenon has been well shown by many writers, and by none more convincingly than by Professor Poulton, in one of the admirable Presidential Addresses delivered by him from this Chair. But the failure of the neo-Lamarckians to establish the principle of specific transmission must not blind us to the fact that the germ-plasm is far from possessing the stability and inviolability with which it was once supposed to be endowed. Weismann himself, with great candour, admitted at a comparatively early stage in his work that the germ-plasm was not in all cases out of the reach of external influences. It is of special interest to us as entomologists that he was led to this conclusion by experiments on a butterfly—the well-known "Copper" (*Chrysophanus phlaeas*). Exposing pupae of the northern golden-red form of this insect to an abnormally high temperature, he found that many of the resulting butterflies were slightly dusted with black. On the other hand, pupae bred from eggs sent from Naples, which would under ordinary circumstances have produced butterflies of the dark southern summer form, were subjected to a relatively low temperature and gave rise to perfect insects in which the normal dark coloration was sensibly diminished. These results, as we shall doubtless all remember, agree with those

obtained by our ex-President, Mr. Merrifield. So far they show, as many similar investigations by other naturalists have done, that it is possible by varying the external conditions to which a butterfly is exposed in its earlier stages, to induce a well-marked alteration in its final aspect. This is the first and obvious conclusion to be derived from these experiments. But Weismann, as I need hardly remind you, was not content to stop at this point. The fact was undeniable that warmth tended to produce in the northern form of the species an approach towards the darkened aspect of the southern race; and conversely, refrigeration brought about in the latter a tendency towards the familiar golden-red of German or English specimens. From this the further inference seemed clear that the difference in aspect of the two geographical races was a direct result of the temperature conditions to which they were respectively exposed during the course of their normal life-history. But it was further to be remarked that in neither series of experiments was the transformation complete. In each instance several members of the brood appeared to be unaffected, and in none did the artificially-produced lightening or darkening reach the same pitch of intensity as in the local races corresponding to the respective conditions of temperature. The most probable interpretation of this result seemed to be that, in Weismann's words, the difference between the two geographical races originated in consequence of "a gradual cumulative effect of the climate, the slight effects of one summer or winter having been transmitted and added to from generation to generation."

At this point we may imagine the neo-Lamarckian asking, "What further proof can be required of the possibility of the transmission of acquired characters?" It is admitted, he would say, that the difference between the northern *C. phlaeas* and the southern var. *eleus* is in some way or other the result of climatic conditions. It has also been shown that these conditions are only partially operative for a single generation. The effect is therefore cumulative. It has not been suggested in this case that the change is an adaptation; no reason has been alleged why in the one instance the lighter and in the other the darker coloration should have been selected as being

in any respect serviceable to the life of the individual. All the successive steps must have resulted directly from certain external conditions; and each step, as it was gained, must have been passed on to the next generation by hereditary transmission, until, in their respective geographical habitats, the lighter and darker coloured races became ultimately fixed. Could there, he might say, be a much clearer case of the validity of Lamarckian, or rather Buffonian, factors?

Clear as the case might seem, it did not satisfy Weismann. He took into account a further fact, viz. that this butterfly in a certain part of its range is seasonally dimorphic, alternating in successive broods between the pale northern and the dark southern form. This state of things he found hard to reconcile with the theory of transmitted somatogenic modification; for if, as he argued, the colour of the race were becoming gradually darker by the inheritance of each step in the process as it appeared in the individual, no light-coloured brood could be produced from dark parents, and *vice versâ*.

There was still another feature in the case to be reckoned with. Weismann's own experiments on *Araschnia prorsa-levana* had taught him that the susceptibility to the influence of temperature is not uniform throughout the whole course of the life-history, but belongs in greatest measure to one particular period—in the case of *A. prorsa-levana,* as he thought, to the early part of the pupal stage. I need here do no more than mention incidentally that this observation has been abundantly confirmed and extended, with modifications, by other investigators, notably by Mr. Merrifield; and, I may add, by Mr. G. A. K. Marshall, whose results, like those of Lt.-Col. N. Manders, are especially valuable as having been obtained under the peculiar difficulties of work in the tropics, and as bringing in the operation of another factor, namely, that of moisture.

There must, then, be some constituent in the composition of the individual which undergoes some successive changes during the period of the individual life-history, and which at one or more stages of its ontogenetic development is capable of being acted upon by external influences in such a way as to produce an obvious alteration in the final condition. But

we have already seen that this effect is not purely a matter of influence upon the individual. The apparent fact of accumulation from generation to generation shows that behind the individual change there must be some element of heredity. Where is this to be sought? Weismann is ready with an explanation which is consonant with his general theory, and which, at any rate, has the merit of accounting for the facts. The modifying influence, he points out, though specially effective at a certain stage in the ontogeny, is not entirely inoperative at other periods. The phenomenon of seasonal dimorphism, as exemplified in the Ligurian race of *Chrysophanus phlaeas*, seems to suggest that the susceptible constituent, whatever it may be, has passed through a preparatory change under the influence of the climate of that region, and so has been brought up to a point where it needs only the finishing touch of the active influence at the specially susceptible ontogenetic stage to push it over into the fully modified condition. This finishing touch is absent during the life-history of the early spring brood, but is supplied by the heightened temperature at which the summer brood pupates; hence the difference in aspect between the two emergences. But where does this store, so to speak, of partly-prepared material reside? Weismann answers, "in the germ-plasm." The constituent in question, or the antecedents thereof, exists within the germ-plasm in a condition which allows of gradual modification by heat, cold, or whatever the influence may be. But inasmuch as it has not reached the specially susceptible stage, the modification may become only slightly manifest, or may even find no visible expression at all. Still it is there; and inasmuch as it belongs to the germ-plasm, it forms necessarily a part of the inheritance of the next generation, and as such may be capable of still further advance in the same direction; this advance being of course limited by the potency of the external influence and by the time during which it has worked. We have here no reflection of somatic change upon the germ-plasm, such as would be supposed to take place under Darwin's pangenesis and similar theories, but a common action upon the antecedents of the final coloration, whether these antecedents are to be found in the

reserve stock of germ-plasm, or in the soma during its ontogenetic development. Thus, according to Weismann, the case of *Chrysophanus phlaeas*, instead of supporting the theory of the inheritance of somatic modification as at first sight it may seem to do, in reality gives additional weight to the theory of the continuity of the germ-plasm, and its independence of somatic change. But it may properly be called an instance of the inheritance of an acquired character, though not in the Lamarckian sense. The transmissible character *has* been acquired; not, however, through the medium of the soma, but directly by the germ-plasm itself. The germ-plasm, therefore, is indeed continuous, but not unassailable by external influences.

This important biological result was, as we have seen, reached by Weismann in consequence of a combined investigation by observation and experiment on a species of butterfly; and it is particularly worthy of note by entomologists that all the data which he could obtain respecting the local and seasonal variations of the form in question proved to be of high significance in the solution of his problem. Without them he could not have reached his conclusion; with further information on these and similar points, he could no doubt have made his explanation still more complete. This is a good illustration of the way in which observation in the field, experiment in the laboratory, and reasoning in the study can combine to establish a result of great scientific importance.

It will no doubt have occurred to you that Weismann's view as to the nature of the seasonal dimorphism manifested in the Ligurian form of *C. phlaeas* ought to be tested by exposing the immature stages of the spring brood of this form to a high temperature. So far as I am aware the experiment has not been tried; and until it has, this part of Weismann's conclusion cannot be accepted without reserve. But as to his view of the susceptibility of the germ-plasm, there has now been abundant confirmation; again, be it noted, by work done on insects.

Standfuss, as Weismann notes, bred some specimens of *Vanessa urticae* under conditions of artificially lowered temperature. The perfect insects showed a departure from

the normal which was no doubt due to the refrigeration,—in this case an increase of dark pigment. Eggs were laid by some of these abnormal specimens, the resulting larvae were reared under normal conditions, and the butterflies on emergence again showed a divergence from the normal form which, though slight, was in the same direction as that of their parents. Similar results with the same species were afterwards obtained by Weismann himself. A still more marked confirmation was supplied by Fischer. Pupae of *Chelonia caja* were subjected to an artificially lowered temperature, and some of the resulting moths showed an extreme degree of melanism. Two of these artificially-produced aberrations were paired, and their offspring were reared under normal conditions. Among the latter were specimens which exhibited in greater or less degree a tendency towards the artificially-induced melanism of their parents. Here we have an excellent case of the apparent transmission of an acquired character. In the light, however, of Weismann's acute reasoning on the subject of *C. phlaeas*, there is every justification for believing that the same interpretation is valid in the present case. The modification is not inherited from the soma of the parent, but is consequent upon the direct action of the external influence upon that parent's germ-plasm.

But all this pioneer work, important and excellent as it is, must yield the palm for completeness and cogency to the laborious researches conducted by William Lawrence Tower, whose treatise entitled "An Investigation of Evolution in Chrysomelid Beetles of the Genus *Leptinotarsa*" is a perfect storehouse of valuable biological material, all derived from the minute study of a single genus of Coleoptera. This admirable publication, which appeared in 1906 under the auspices of the Carnegie Institution of Washington, has perhaps in this country hardly met with the attention which it deserves; though now that Professor Bourne, in his recent Presidential Address to the Zoological Section of the British Association, has drawn public attention to the work, it may be expected that greater appreciation will be shown of the extremely interesting results which it contains.

Among the numerous and carefully-planned experiments

undertaken by Tower, there are some which have a direct bearing on the matter under consideration. Of these I propose to give a brief account. It should be premised that the beetles of the genus *Leptinotarsa* lay their eggs in batches, each batch being laid before the next begins development.

Experiment 1.—Males and females of *L. decemlineata* were exposed to extremely hot and dry conditions, accompanied by low atmospheric pressure, during the growth and fertilisation of the first three batches of ova. These were reared from the outset in normal conditions. Out of 96 specimens so obtained, 82 were of the varietal form *pallida.* After the deposition of the first three batches of ova, the same parent beetles were placed in normal conditions, and two more batches were laid. These, reared under natural conditions, gave normal *decemlineata,* which continued to breed true to type. The origin of the *pallida* forms may therefore fairly be ascribed to the abnormal conditions to which their parents were for a time exposed. Two of these *pallida* males were mated with *decemlineata* females; the resulting hybrids resembled normal *decemlineata.* Now comes an interesting point. This generation of apparently normal *decemlineata* gave, when bred *inter se,* offspring consisting of *pallida, decemlineata,* and *decemlineata*-like hybrids in Mendelian proportion. The *pallida* of this generation bred true, being evidently extracted recessives; the *decemlineata* and hybrids broke up again in Mendelian fashion. This most interesting experiment points to at least three results of great biological importance. The first, which is that in which we are more immediately interested, is the confirmation of Weismann's view as to the accessibility of the germ-plasm to external influences. The second is the demonstration that just as the somatic plasm has a period of highest susceptibility, which fact was known to Weismann at the time of his *C. phlaeas* experiments, so also the germ-plasm itself has a similar period. This was not known to Weismann; if it had been, it might have led him to modify in some respects his conclusions from those experiments. The third point is the establishment of the fact that the type-form of a given species may stand in Mendelian relation with a variation of that species artificially induced by interference

with its germ-plasm. The interest and importance of these results is manifest, and it is well to remind ourselves once more that they all emerge from the careful study of an insect.

Experiment 2.—Males and females of *L. decemlineata* were subjected to hot dry conditions, and afterwards to normal surroundings. During each period they deposited eggs. From the eggs deposited in the second period, that of normal conditions, pure *decemlineata* were bred for ten generations. But from the eggs of the first period came many aberrant forms, together with a certain number of apparently typical *decemlineata*. These latter were reared side by side with the *decemlineata* of the second period, which, as we have seen, behaved in a perfectly normal manner throughout. But the *decemlineata* of the first period, after giving rise to a generation of apparently quite normal forms, suddenly developed into a race with an annual cycle of five generations instead of the normal two, and continued to exhibit the same abnormality up to the fourteenth generation, when the experiment ceased. Here we have a physiological instead of a structural peculiarity imposed upon the germ-plasm by artificial means, and giving rise to a permanent race. It should be mentioned that, in the words of Tower, "none of the beetles of the *lineata* group, to which this beetle belongs, have more than two, or rarely three, generations per year, and there are none known in the genus that have over three." Another point that emerges is that the application of the stimulus need not always be immediately followed by the obvious response. In the present experiment one whole generation elapsed before the race began to show the effect of the abnormal treatment to which its progenitors had been subjected.

Experiment 3.—In another experiment with the same species the conditions were varied by using heat in combination with moisture. In other respects the procedure was the same. From the eggs of the second period eight successive generations were reared, giving nothing but pure *decemlineata*. From those of the first period, that of abnormal conditions, came a large number of unmodified *decemlineata* and a certain number of the form *melanicum*. Both of these forms bred

true in normal surroundings. The generation also included a single male specimen of the form *tortuosa*, which crossed with a female *decemlineata* yielded hybrids with *decemlineata* dominant. These in succeeding generations split up in Mendelian fashion, the *tortuosa* (extracted recessives) breeding true.

Experiment 4.—The subject of this experiment was the tropical species *Leptinotarsa multitaeniata.* Here, again, the parent beetles were exposed during the first period of egg-laying to artificial conditions of heat and humidity, while during the second period the surroundings were normal. The results obtained were analogous with the preceding. The second batch produced nothing but *multitaeniata* for four generations, when the experiment ceased. The first batch gave together with typical *multitaeniata* a much larger number of the form *melanothorax.* The two forms were separated, and each continued to breed true under normal conditions.

Experiment 5.—In this experiment, the subject of which was again *L. multitaeniata*, the egg-laying period was divided into three instead of two portions. The first and third were passed under normal conditions, the second under the artificial conditions of the last experiment. The first and third batches of eggs gave nothing but typical *multitaeniata* ; the second consisted entirely of the forms *melanothorax* and *rubicunda*, each of which continued to breed true.

Experiment 6.—Finally, a similar experiment was tried with another tropical species, *Leptinotarsa undecimlineata.* Again the result was the production by artificial means of a varietal form (*angustovittata*), which continued to give pure descendants showing no tendency towards reversion.

After these experiments there seems no possible room to doubt that the germ-plasm is accessible to external influences, and that it may by these means be transformed in such a way as to give rise to a permanent race of descendants showing marked differences from the parent form.

I will not now stop to discuss Tower's interpretation of the results of these and his numerous other experiments. His theoretical views seem to me to differ in value, some being weighty in the extreme, and a few, to say the least, question-

able. But there can be no dispute as to the high importance and interest of the facts that he has brought together, and I trust that the examples I have given may induce entomologists who are interested in the study of evolution, and by whom these researches may hitherto have been overlooked, to make themselves acquainted with this mine of valuable information. They may not find themselves able to agree with the author at all points, but they will be introduced to a great mass of material with an important bearing on the nature and causes of variation, the working of heredity, the efficacy of selection, the significance of warning colours, and many other matters essential to a proper comprehension of the problem of evolution.

There is one other phase of this great problem about which I should like to say a few words, because here again our special entomological studies have an important part to play. They have already contributed much towards the comprehension of this side of the question, and I am convinced that they are capable of leading to a still further advancement of knowledge in the same direction. I refer to the psychic aspect of evolution.

It was fully recognised by Darwin himself that mental no less than physical characters are subject to evolution. The same principle was adopted by Wallace, not, it is true, without reservation, and received at his hands some interesting developments. But to Professor Mark Baldwin belongs the principal credit of insisting on and driving home the fact that evolution is psychophysical; that, as he puts it, "there are not two evolutions, one 'organic' and the other 'mental,' but that mind and body have evolved by one process and in one series of graduated stages." Now in order to illustrate in a forcible manner the interdependence of physical and psychic phenomena in evolution, he has recourse to the theory of warning colours in insects. This he expands in the following manner: "As preliminary to the theory there is the fact of coloration, which is distinctly physical. The question is as to its origin. The theory holds it to be due to the warning given to other individuals that a particular colouring is distasteful or poisonous. Now in order that this warning be given, the

biologists tell us there is necessary a certain education of the hostile individuals. The creatures have to learn the meaning of the coloration; and this learning involves profiting by experience. . . . Here is as distinctly a mental process involved as any one might cite. . . . The action of natural selection, I may add for completeness, secures the survival of the insects so coloured, seeing that being warned, their enemies let them alone. The possibility of the evolution of the definite coloration turns, in fact, upon this series of psychological processes."

Here the psychic endowment of the enemy is seen to be a factor in the evolution of the prey; and it may of course be added that to ensure for the warning colour its full effect, it is necessary that its owner should possess the appropriate habits. Similar instances will at once occur to every field naturalist. Protectively-coloured insects instinctively seek corresponding surroundings. An interesting case of this is the fact which now seems fairly well established of yellow and white butterflies selecting for resting-places the neighbourhood of leaves or flowers of similar colour. Dr. Longstaff's excellent plate, drawn from nature, of the resting habit of *Eronia cleodora* will occur to many of you. I ought to apologise for dwelling on so familiar a topic, but the fact really requires emphasising that the raw material of selection is neither purely physical nor purely psychical, but a complex of the two. The admission of this fact, so patent to every observer of insects, has important consequences. For as soon as we can recognise a rudimentary form of mentality—the gaining of a definite result by the method of trial and error—we have a basis for habit, for memory, and eventually for the higher psychological faculties. In the instances that I have mentioned of the correlation of appropriate habits with a protective colouring, there is no reason to suppose the presence of anything like conscious accommodation; the actions in question are no doubt instinctive in the strictest sense. But quite low down in the animal scale, and even, I think it will be conceded, among the insects, we get indications of "residual processes left by actual experiences" leading to what can only be called memory. These processes, of undoubted utility, may

no doubt serve in their day, as Professor Baldwin says, until reinforced and possibly superseded by congenital variations tending in the same direction. Memory thus established as an inborn faculty, "the experimental use of memory images, with corresponding success and utility, would be followed in time by further variations, giving imagination and thought" (Baldwin).

In the higher animals we have no difficulty in perceiving the co-existence of individual plasticity with the congenital endowments of both mind and body. Instinct, one of these congenital endowments, is not "lapsed intelligence," though intelligence may be suffered to lapse if and when instinct is ready to take its place. On the other hand, the reverse process may and does occur. Instinct may fall away and disappear before the encroachments of the increasing power of individual accommodation, a power which is rooted in the plasticity, and, to use Sir E. Ray Lankester's term, the "educability," of the psychic organisation. This final stage is naturally of most frequent occurrence in man. The relative proportions of the two principles are regulated by natural selection; the best combination in regard to any given purpose is the one that will win.

Now the special application of these considerations to Entomology I take to be this. The later stages of psycho-physical development are comparatively accessible to our observation. In the phylogenetic range of the higher vertebrates, and the ontogenetic history of man, we have much material for the study of the interplay of plasticity, educability and power of individual accommodation, with the congenital endowments of a relatively fixed and stable character, such as instinct and the fundamental features of bodily structure. But the earlier steps in the process are involved in much obscurity. What do we really know, for example, of the relative value of the parts played by psychic plasticity and fixed instinct in the case of the lowest organisms? And can we be sure that to any large extent the growth of instinct has been in their case actually screened by powers of functional accommodation? What we *have* ascertained on these points has been, I venture to say, largely or chiefly due to the

labours of entomologists. Fabre, Avebury, Wasmann, Forel are names that will occur to everybody as those of men who have done much in their several ways to help on an answer to these and kindred questions, and who have shown the road which future investigators may pursue with profit. And the study of the social hymenoptera has a further bearing upon a development of evolutionary theory of the greatest importance, for it introduces us to the conception of the *group* as the selective unit instead of the individual, and so leads on to the evolutionary side of sociology and ethics, with their accompaniment of organisation within the community, of imitation, of tradition and the social sense.

This is a tempting subject, and I would gladly pursue it further did time permit. But I think I have now said enough to illustrate my contention that entomologists enjoy peculiar advantages in the attack of the great outstanding problems of evolution. It is unquestionable that such a mind as that of Herbert Spencer, capable of welding together into a concordant whole a mass of facts and conclusions drawn from every department of knowledge, is an asset of enormous value to the cause of scientific progress. But it should never be forgotten that the work of the specialist is equally essential; it is he who supplies material without which the generaliser and unifier of knowledge could not work. And let us beware of undervaluing kinds of work which do not happen to appeal to our own individual tastes. I think no one can give attentive consideration to the topics that have been touched on this evening without seeing that our study has need of the morphologist, the physiologist, the field naturalist, the museum worker, the laboratory experimenter, the systematist, and—shall I add?—the arm-chair philosopher. Each one of these has his contribution to make to the common fabric of organised and unified knowledge.

VII. *On Diaposematism, with reference to some limitations of the Müllerian Hypothesis of Mimicry.* By Guy A. K. Marshall, F.Z.S.

[Read February 5th, 1908.]

One of the most striking features in connection with the philosophical study of the phenomena of Mimicry among butterflies in recent years has been the marked tendency to lay an ever increasing emphasis upon the importance of the selective factors suggested by Fritz Müller and to minimise the influence of what is known as Batesian Mimicry. It has even been suggested that every known case of mimicry among butterflies can be more satisfactorily interpreted as being due to the operation of Müller's principle. The essential difference between these two theories of mimicry lies in the fact that one explains how an edible (or less unpalatable) species will derive advantage through assuming a superficial likeness to another which possesses nauseous (or more unpalatable) qualities (Batesian mimicry); whereas the other shows how one nauseous species will benefit by mimicking another having the same qualities (Müllerian mimicry). Now although there can be little doubt that a good many cases of mimicry originally adduced in support of Bates' theory must now be explained on Müllerian lines; yet the universal application of this latter principle to butterflies, involving, as it does, the assumption of unpalatability in every mimic, seems open to some serious objections which may be considered later.

Perhaps the principal stimulus to the recent extension of Müller's interpretation of mimetic resemblances has been furnished by an hypothesis which has been developed by Dr. F. A. Dixey. It was in his important and able memoir on the Phylogeny of the Pierinæ (Trans. Ent. Soc., 1894, pp. 249–334) that Dr. Dixey first outlined his conception of Diaposematism, or Reciprocal Mimicry, as it was then called. This conception consists practically of a widening or complication of the principle put forward by Müller to explain the inter-resemblances between distasteful butterflies belonging to different genera. For

although Müller evidently conceived, and briefly mentioned, the possibility of a mutual approach between two such species (Proc. Ent. Soc. 1879, p. xxviii), yet his theory was generally interpreted as involving only a one-sided approach from one species to another. On the other hand the hypothesis of Diaposematism specially emphasises the probability of a mutual simultaneous approach. To use the author's own words: "There seems to be no reason why, especially if there is no conspicuous inequality of numbers, there should not be a kind of 'give and take' arrangement between mimicker and mimicked, the latter advancing some way to meet the former for their mutual benefit. In other words, when two species, A and B, form an association of this kind, it need not be supposed that the form of A remains fixed, while B assimilates itself to it, or *vice versa*; but the association may really be formed by both A and B converging to a point between them, or, in short, mimicking each other. The acceleration of the process, which in many cases would result, must of itself be an advantage." (Trans. Ent. Soc. 1894, p. 297.) And again: "In the latter case (Müllerian Mimicry) the mimetic attraction is unlimited and mutual, acting reciprocally in both directions, and influencing each member of the group." (Trans. Ent. Soc. 1897, p. 325.) This line of argument was also advocated in the Transactions for 1896 (p. 72), and since that time various specific cases have been published by Dr. Dixey, Professor Poulton and Mr. S. A. Neave, which are considered to furnish convincing proof of the validity of the hypothesis of reciprocal mimicry. Indeed, it has been held that these proofs are so cogent that Diaposematism should no longer be regarded as a mere hypothesis, but that it is now entitled to rank as an established law (Proc. Ent. Soc. 1906, p. lxxi).

But before looking into the details of these cases it may be well to examine the whole conception from a more general standpoint. It has already been remarked that reciprocal mimicry is merely a complication of Müller's theory, and it is therefore important to have a very clear idea of the essential nature of that theory, of the factors which make for a Müllerian Association, and of the conditions which are most favourable to its development. The real starting-point for the Müllerian hypothesis lies in the proposition (sufficiently well established by now)

that young insectivorous animals are not born with an instinctive knowledge of what insects are good to eat and what are not. The slow flaunting flight and conspicuous coloration of a *Danaida* or a *Heliconius* can have no special significance for a young bird when it first starts out in life to forage for itself. The knowledge that these butterflies possess a pronouncedly unpleasant flavour can only be acquired as the result of direct experiment, and probably several butterflies would be destroyed by such a bird before it succeeded in permanently associating the conception of unpleasantness with any particular colour-pattern. Thus each species with an independent type of warning coloration would have to lose a certain percentage of its individuals before its true significance could become a matter of common knowledge among all the young and inexperienced insect-eaters in any particular neighbourhood. From this Müller argued that if two such species, having different colour-patterns and inhabiting the same area, were to develop the necessary variations leading up to a mimetic association, such a combination would be of considerable utility in relation to the experimental tasting of young birds; for then both species together would only have to contribute the same number of victims which each of them would have to furnish if their colours were different.

Given the initial variation, such a mimetic resemblance can only be built up through the operation of some eliminative or selective factors which shall result in an advantage to the variation as compared with the typical form from which it is derived; thus leading up to the gradual replacement of the latter by the former. And it may be noted that, with the exception of resemblances in which mere affinity has obviously played a great part, the closer the mimicry, the greater must have been the persecution of the mimic (whether Batesian or Müllerian) and the higher the percentage of its elimination. In the case of Müllerian mimicry, as we have seen, the selective agent is provided by the destruction due to the experimental tasting of unpalatable insects by inexperienced insectivorous animals. This may be briefly denoted as the "Müllerian factor."

There are certain points in connection with the operation of this factor which it is well to bear in mind. In the first place, the differences in the relative intelligence of

the butterflies' enemies will affect the results due to their attacks. Those which exhibit a high degree of intelligence will obviously profit more quickly by their experience; in other words, they will acquire the necessary mental association between colour and inedibility by the destruction of comparatively few butterflies. They will therefore operate much less efficiently as producers of Müllerian mimicry than will those enemies which have a comparatively low degree of intelligence and which therefore require to make many experiments before arriving at the same result. But if there be enemies still lower in the scale and incapable of forming such a mental association at all, then the destruction of butterflies which they would cause would have no effect whatever from a purely mimetic standpoint; no more than if the insects had been killed by a torrential thunderstorm. Similarly if we suppose that a certain species of bird has specially adapted itself to feed on a genus of insects usually avoided by other insectivorous animals, the attacks of that bird will have no effect in the direction of Müllerian mimicry on that particular genus. In other words, the mental attitude of the enemy towards its prey has an important bearing upon the results which its attacks will produce. Finally, the accumulation of experience does not render an animal more effective as a Müllerian factor, but precisely the reverse; for as it becomes more skilled in recognising nauseous species, so will it gradually cease its experimental destruction, upon which this kind of mimicry so essentially depends.

If we turn for a moment to consider whether these arguments are equally applicable in the case of Batesian mimicry, we find, on the contrary, a totally different state of affairs. So far from experience and intelligence being adverse qualities, it is evident that the greater the accumulation of experience and the higher the degree of intelligence possessed by the insectivorous animal, the greater will be its efficiency as a producer of Batesian mimicry. For it will thus be the better enabled to discriminate between the edible mimic and its inedible model, with the result that there will be a more effective selection and a keener elimination of those variations of the mimic which do not come up to a high standard of resemblance. A consideration of this difference in the operation of these two mimetic forces would appear to

justify the expectation that the elimination due to the Batesian factor would be competent to produce a higher degree of inter-resemblance than would the factor adduced by Fritz Müller.

Another point worth noting is the difference in the periods of incidence of these two processes of selection. The Müllerian factor is, as we have seen, supplied entirely by young and inexperienced birds, etc.; it will therefore have its greatest effect during the summer months when such young animals would be most numerous. As the season advances, however, these animals would be increasing in wisdom and experience, and consequently by the autumn or early winter we may reasonably suppose that their efficiency as producers of Müllerian associations will have very notably diminished. Now from this time onwards until the early months of the next summer there will be no further appearance of young broods of insectivorous animals; and it seems clear that for a considerable portion of the year the forces which make for Müllerianism will be at a very low ebb, if not altogether absent. On the other hand, there seem to be no grounds for assuming the existence of any such period of marked diminution in the factors which make for Batesian mimicry; for in most tropical countries butterflies (which are here alone being considered) are fairly plentiful throughout even the winter months, while there is a much greater reduction in the insects of most other orders (*cf.* Trans. Ent. Soc. 1902, p. 432). Thus, although a large number of insectivorous migrants will have departed at that season, the scarcity of other insects, in conjunction with the comparative conspicuousness of butterflies, will doubtless lead to a maintenance, or even an increase, of the percentage of destruction by the remaining resident birds. The incidence of Batesian elimination, therefore, will be comparatively continuous and persistent.

Having thus briefly examined some aspects of Müller's selective factor, we may now endeavour to ascertain the conditions which will render it most effective in fostering mimetic associations. The position of affairs will be best appreciated by taking some hypothetical case. Let us assume therefore that within any given area there exist two species of butterflies, A and B, possessing nauseous qualities in about the same degree, but having different warning colour-patterns; and further that within the

same area the education of young birds, lizards, etc., necessitates the destruction of approximately 1000 individuals in each group of distinctive patterns. Again, let us suppose that A is a common species and is represented by 100,000 individuals in that locality, while B is more scarce and has only 5000. Now, *ex hypothesi*, the Müllerian factor will exact an equal toll from the two species, and its selective importance must therefore depend upon their relative numbers. In the present instance the plentiful A will lose only 1 per cent. of its individuals from this cause, while the scarcer B will lose no less than 20 per cent. It is therefore reasonable to suppose that if certain individuals of B chanced to develop a variation in the direction of A, that variation would have, in relation to the Müllerian factor, a definite advantage over its own typical form, because it would tend to share, at least to a small extent, in the relative advantage enjoyed by A; and the continuance of the elimination would gradually tend to enhance the variety and to diminish, and finally exterminate, the type. This would be a case of simple Müllerian approach from B to A. But if the mimicry is to be reciprocal it must be shown that A is capable of approaching B by a precisely similar process. In order to simplify the argument let us make the supposition that 10,000 specimens of A simultaneously present a sudden marked variation in the direction of B, to such an extent that young birds would be liable to rank them with B rather than with A; what will be the effect of the Müllerian factor on this remarkable variety? The point again to be considered is the relative incidence of the destruction. There will now be 90,000 examples of the A pattern, and 15,000 of the B pattern. If 1000 individuals of each are again destroyed by experimental tasting, a simple calculation shows that the percentage of loss due to this factor will be six times greater in the variety of A than in the typical form of A. In fact the result is exactly the opposite of what took place in the case of the variety from B towards A. Whereas there we found that the variety had an appreciable advantage over its own type form, here it is seen to be at a distinct disadvantage. It is obviously impossible for the Müllerian factor to build up a mimetic resemblance on such a foundation; if it have effect at all, that effect must be to gradually eliminate the variety and to establish

the type form. In these particular circumstances it is clear that the simultaneous and mutual mimicry, postulated by the hypothesis of Diaposematism, is entirely out of the question. The Müllerian factor is capable of converting B into a mimic of A, but it cannot cause A to mimic B.

This simple example illustrates several interesting points. In the first place, it shows that the whole idea of Müllerian mimicry practically resolves itself into a numerical computation of the relative percentages of loss. The only kind of variation which can have any significance will be one that shall be trending from a form having a higher percentage of loss towards one having a lower percentage; so that a difference in these percentages is an essential condition for the production of Müllerian mimicry. But Müller's hypothesis postulates that the absolute destruction is practically constant for each group of different colours, and therefore the necessary conditions can arise only where there is a noticeable difference in the initial numbers of the two species involved. Further, the greater the discrepany between these two numbers, the greater will be the advantage derived by any variation from the rarer species in the direction of the more numerous, and consequently the more powerful and rapid will be the operation of the Müllerian factor in producing a mimetic approach. This therefore constitutes the most highly favourable condition for the evolution of Müllerian mimicry. Conversely, as the numbers approach one another, so will the value and importance of the initial variation from the numerically smaller species towards the larger become less and less; so too will steadily diminish the effectiveness of the Müllerian factor as a producer of mimicry. Finally, when we arrive at a case where the two species are equal in numbers, there will then be a condition of equilibrium, and the Müllerian principle will practically cease to operate altogether.

So far as concerns the variations which may arise from the numerically larger species towards the smaller, these will be the more rapidly exterminated, the greater the discrepancy in the numbers of the two species. As this difference diminishes, the disadvantage of such a variety, as compared with its typical form, will also diminish; but in no case can its development be fostered and increased through the medium of the Müllerian factor, because it still remains a variation in a disadvantageous direction.

Further, as the numbers approach each other, any variation from the larger towards the smaller tends to produce equality, a condition which effectively prevents the Müllerian selection from producing any mimetic results. We see then that a Müllerian approach will only take place in one direction, namely, from a rarer species towards a more abundant one, and no species can in this way approach another which has fewer individuals (and therefore a higher percentage of loss) than itself.

If this conception of the conditions which make for Müllerian mimicry be accepted as sound, it would appear that the hypothesis of Diaposematism is placed on the horns of a veritable dilemma. For this hypothesis differs in no real essential from Müller's principle, of which it appears to be merely an extension; and yet we find that the very conditions which are most highly favourable for a simple Müllerian approach are at the same time absolutely fatal to anything in the way of reciprocal mimicry. On the other hand, this latter conception only begins to appear feasible at the other end of the series, namely, where the numbers of the two species approximate equality. But we have seen that this is a condition which renders any occurrence of Müllerian mimicry in the highest degree improbable; and there can be no Diaposematism where there is no Müllerian mimicry. In my opinion, the above considerations render it difficult to accept the essential idea of reciprocal mimicry even as a mere working hypothesis.

Now it may be urged that the statement as to the practical impossibility of Müllerian mimicry when the numbers of the two species are equal cannot be maintained, and that its unsoundness can be demonstrated by some such illustration as the following. Supposing that A and B are each represented by 20,000 individuals and that they lose 1000 apiece from experimental tasting when their colours are different; then if they enter into a mimetic association they will only lose 1000 out of 40,000; in other words, their losses from this cause will be reduced by one-half. Here is a clear and decided advantage, and therefore it may be claimed that the Müllerian factor must have scope to produce such a mimetic approach.

But before hastening to accept this conclusion it is well

to point out that unless due care be exercised in the use of this kind of argument from advantage, it is liable to lead to erroneous conceptions. In order to show this more clearly let us apply the same line of argument to a slightly different case. If we suppose that there are 20,000 examples of A and only 10,000 of B, each losing 1000; then when A stands alone it will lose 5 per cent. of its numbers. But if A develops a mimetic tendency in the direction of B, and finally becomes a mimic of that species, then its loss from experiments will be reduced to only $3\frac{1}{3}$ per cent. Here again there is a clear advantage as compared with its previous condition, therefore it will be claimed that the Müllerian factor must be capable of converting A into a mimic of B.

Now we have already seen that where the numbers of A are considerably in excess of those of B, as in this case, any initial variation (in the Darwinian sense) from A towards B will be going from a lower percentage of loss in the direction of a higher percentage, and that therefore that variation will be at a disadvantage as compared with its own type form, in relation to the factor which is causing the loss. In such circumstances therefore the Müllerian factor cannot convert A into a mimic of B.

Here then these two lines of argument, based on the same data, have led to diametrically opposite results. The reason for this divergence is not far to seek. It will be observed that the contention in favour of a Müllerian approach from A to B is based entirely on a consideration of the advantage which would accrue *when the mimicry had become an accomplished fact,* while the intermediate stages are in no way taken into account. But the whole Darwinian idea of the evolution of such a case of mimicry involves the assumption that it has been built up by a gradual process of selection from comparatively small individual variations. Therefore the essential point to be considered must be the question of relative advantage as between the *initial* variation and its typical form; and the assumed ultimate advantage has no real significance unless it can be shown that the initial variation has some definite advantage over the type in relation to the selective factor which is considered to cause the mimetic approach. Where this point is overlooked, an argument based merely on a supposed eventual gain may, in some cases, be entirely misleading.

On reverting to the case where the two species have equal numbers and applying the above test, we find that the contention in favour of a Müllerian approach cannot reasonably be maintained. If A and B are equal, then their position in regard to the Müllerian factor is absolutely identical, so that neither has an iota of advantage over the other and the essential condition for the origin of Müllerian mimicry is lacking. In these circumstances it is evident that any small variation from one towards the other will not practically affect the numerical relationship of the two species and will therefore have no mimetic value.

The comparative numbers of individuals in Müllerian Associations.

Unfortunately we have very little knowledge as to the approximate individual numbers of the species forming any Müllerian association; but in November 1903, Professor Poulton exhibited to this Society (Proc. Ent. Soc. 1903, p. liv) a series of 323 butterflies captured on a single day by Mr. C. B. Roberts in British Guiana, with a view to giving an idea of the relative numbers of the species in that spot. Out of the total no less than 295 specimens, comprising 9 species, fell into the mimetic association which centres round the common *Melinæa mneme*, all of them belonging to undoubtedly distasteful genera. *M. mneme* itself vastly outnumbered the other species, being represented by 253 individuals, while the remaining 8 species were represented by the following numbers: 8, 9, 10, 9, 1, 3, 1, 1. There seem good grounds for supposing that these figures do give a fair rough idea as to the relative occurrence of these species in that locality, and the very striking discrepancy in the numbers of the mimics as compared with their dominant model is precisely what we should expect to find on the conception of Müllerian mimicry here advocated. Such conditions would be specially favourable to the production of a large mimetic association, and it seems highly probable that in actual practice Müllerian mimicry will only have arisen where the discrepancy in numbers has been fairly considerable; although the possibility of its occurrence where the difference is comparatively small can, of course, be theoretically upheld.

Alternating Resemblance.

Although there appear to be serious difficulties in the way of accepting any idea of mutual simultaneous mimicry between two unpalatable species, yet it is not impossible that a certain interchange of characters might still take place between them. For example, at first A might be more numerous than B and a simple Müllerian approach might take place from B towards A. While this was in progress conditions might arise which would cause a reversal in the relative numbers of the two species, so that B would become the dominant partner. Then any further mimetic approach that might take place would be from A towards B, so that the final result might show a fusion of the original colours of the two species. This kind of approach is quite different from that contemplated in the hypothesis of Reciprocal Resemblance, although producing similar results; it may therefore be distinguished under the name of Alternating Resemblance. It is not probable that this phenomenon will be of common occurrence in nature, and it is only here referred to in order to show that even if the actual existence of reciprocity can be demonstrated, that will not of itself afford proof of Diaposematism; for the facts can be consistently interpreted on the lines of a one-sided Müllerian approach.

Since the foregoing remarks were written Professor Poulton has kindly suggested to me a criticism which appears, at first sight, to lend some support to the idea of Diaposematism. As a very similar suggestion has been made to me independently by another friend, it seems advisable to show how it may be met.

It has been contended that among the enemies of the two distasteful butterflies, A and B, there will be some (which we may call X) whose first experience will be entirely of A. Having thoroughly learnt that this insect is unpalatable they will then come across B. If among the individuals of B there occurs a variation (B′) which presents a roughly A-like appearance, then B′ will have an advantage over B in relation to the attacks of X. Similarly other enemies (Z) will first have experience of B only, so that when they afterwards attack A, the variety A′, which has varied in the direction of B, will be at an advantage as compared with A, because it will recall to

the mind of the enemy unpleasant experiences in connection with B. On these grounds it is argued that both varieties, A′ and B′, are advantageous, and that therefore the two species can mimetically approach one another at the same time. But a little consideration will soon show that the above argument does not deal with all the factors in the case. In the first place, the enemies are divided into only two categories (X and Z); but there must obviously be a third (Y) which will derive its knowledge through a mixed experience of A and B together, and the effect of this has been quite left out of consideration. Now it is evident that reciprocal mimicry could only take place where A and B are approximately equal. When this is the case, the law of probabilities shows that the numbers of Y will be very large, those of X and Z very small; therefore the net result of the Müllerian factor will depend upon the effect produced by Y, and this is entirely covered by the general argument set forth above, which thus remains unaffected.

There is yet another more important objection to this criticism. It is contended that X will discriminate between B and B′, and Z between A and A′, to the advantage of B′ and A′ respectively; but the relation of X to A and A′, and Z to B and B′ is not taken into account at all. But if A′ is sufficiently different from A that Z will discriminate between them, it must be admitted that X will do so likewise. Such discrimination means that A′ will be subjected to special tasting experiments by X, as apart from A. But *ex hypothesi* the numbers of A′ will be very much smaller than those of A, and therefore these experiments will involve a much higher percentage of loss for A′ than for A, so that the former will be at a decided *disadvantage* in relation to the attacks of X. The same applies to B′ with regard to the attacks of Z. Thus A′ will have an advantage over A during the attacks of Z, and a disadvantage during those of X, and the net result will depend upon the relative numbers of X and Z. But the relative numbers of X and Z are directly dependent on the relative numbers of A and B respectively; for where A is abundant the members of X will be large and *vice versa*. Therefore when A and B are equal, X and Z will be equal, and the advantage which A′ derives from Z will be balanced by the disadvantage due to X; and similarly for B′. In these circumstances there will be a condition of

equilibrium so far as concerns the Müllerian factor, and no mimetic approach will take place. Again, where A is largely in excess of B, X will be large and Z small; therefore the disadvantage accruing to A′ will be large, the advantage small, the net result being a considerable disadvantage; so that the effect of the Müllerian factor will be to stamp out A′ and to establish A, in other words, to prevent its mimicking B. It is thus evident that so far from upsetting my general argument this criticism merely serves to confirm it when all the factors are taken into account.

We may now turn to an examination of the various cases which have been cited as furnishing conclusive evidence as to the actual occurrence of diaposematic resemblances. In looking at these as a whole an interesting fact emerges, namely, that no example has yet been brought forward as occurring between any two of the most dominant distasteful groups of the world, viz.: Danaini, Euplœini, Lycoræini, Ithomiinæ, Heliconinæ and Acræinæ; although it is among some of these groups that Müllerian mimicry finds its highest development, and cases of reciprocity should be evident and numerous, if Diaposematism be a *vera causa*. Perhaps it is a mere coincidence that in the great majority of instances cited (5 out of 7) one of the mimetic forms belongs to a species not generally considered to be unpalatable. But it has been claimed that the establishment of a case of diaposematic resemblance is of itself good evidence of the unpalatability of both species involved. This claim is obviously justifiable only where it can be shown that it is impossible to interpret the facts on any hypothesis other than Diaposematism; and such a case has not yet come under my notice. It was in connection with this aspect of the question that I first found myself in conflict with this theory; for its application has led to the assumption that the coloration of certain South African butterflies has a warning significance, indicating the existence of distasteful qualities, whereas my own observation of the insects in the field (supported by a few experiments) has led me to an entirely opposite conclusion. These divergent results have induced me to undertake a closer examination of the foundations upon which the hypothesis of Diaposematism has been built.

I. *The Association of* Pereute *and* Heliconius.

This case is of special interest because, with the next one, it furnished the original basis for the theory we are considering. It was dealt with by Dr. Dixey in Trans. Ent. Soc. 1894, p. 296, and further discussed in the Trans. for 1896 (p. 72). The facts are briefly these: Certain forms of the Pierine genus *Pereute* in Tropical America exhibit an undoubted mimetic approach towards the common *Heliconius melpomene* and its allies, whose upper-side colouring is plain brown, with a broad red band across the fore-wings. Now many species of *Pereute* have on the under-side some distinct red spots at the base of the hind-wing. Somewhat similar markings also occur in the *Heliconii,* but Dr. Dixey, quite justifiably, refuses the explanation that these spots have been acquired by the *Pereute* as part of their mimetic resemblance to *Heliconius.* For he shows that not only can we find similar markings in other American Pierines which have no mimetic relationship with *Heliconius* or any of the red-spotted Papilios, but further they are shown to occur independently in Pierine genera in other parts of the world; notably in some species of the distasteful Eastern genus *Delias,* to which he considers *Pereute* to be nearly allied. On these grounds the spots are claimed as being Pierine in character. How then are we to explain their presence in *Heliconius*? Any argument for parallel development is rejected by Dr. Dixey, for he says: "If we assert them to be purely 'accidental,' we are met by the fact that although they are found in some species of both *Papilio* and *Heliconius* that are apparently not the subject of mimicry, yet they are most distinct and most prevalent in those species which are copied by Pierine imitators" (*l. c.* 1894, p. 296). Hence it is contended that the only satisfactory explanation is that, in this particular respect, the *Heliconii* have been influenced by, and approached, the *Pereute,* and that therefore the red spots constitute a reciprocal or diaposematic character.

Now, in order that any case of this kind may really carry conviction as a proof of diaposematism it is necessary to show that the reciprocal character which the model is claimed to have acquired from the mimic must be one that is abnormal in the genus of the model and its allies. For if the character occurs frequently and independently

in other members of the same genus its appearance in any one species might well be due to simple affinity with them and not to mimicry at all. The fact that the model and the mimic possessed *ab initio* certain superficial characters in common would of itself render a mimetic approach the more probable; yet the occurrence of these similar markings would, in no sense, be due to mimicry, and no argument for diaposematism could be founded upon them.

The first point therefore to be investigated is the occurrence of this red spotting in *Heliconius*. With the accession of the splendid Godman and Salvin collection the British Museum now possesses a very fine series of this genus. A careful examination of this material, based on Riffarth and Stichel's monograph of *Heliconius* in the "Theirreich," shows that out of the 71 species recognised by these authors no less than 35 * possess basal red spots on the under-side of the hind-wings. Of the remaining 36 species about three-fourths have been drawn away in mimicry of the great *Melinæa-Mechanitis* association, and the absence of red spots may perhaps be actually due to this mimicry; for I have been unable to find that any genus of Ithomiinæ or Danainæ possesses this kind of marking. The *Heliconii* in which the red spots are present belong to various different types of coloration, several of which do not appear to be mimicked by Pierines, and in some of these the red spots are very highly developed, more so than in any non-mimetic American Pierines. Nor does there appear to be any constant connection between general mimicry and the development of the spots. For example, *Pieris locusta* ♀ roughly mimics *H. cydno-galanthus*, and the nearly allied *P. noctipennis* ♀ mimics *H. sapho-leuce* (Dixey, "Nature," Oct. 1907, p. 677); the under-side red spots of the two *Pieris* are almost identical, yet those of the *Heliconius* differ very much from them and from each other.

Turning now to *Percute* we find that the colour of the under-side of the hind-wing may be generally described as dark brown with a variable yellow costal streak, and with, or without, two or three basal red spots. With regard to the upper-side colouring the genus may be

* It may be noted that the great majority of these species also have a red streak along the base of the costa of the fore-wing on the under-side, a character which I have failed to find in any American Pierines.

divided into three sections. In the first, comprising only the more primitive *telthusa*, the sexes are alike, being blackish, with white markings and an irroration of grey scaling; the under-side having *three* red spots. In the second the sexes are again alike, both being black, with a red bar across the fore-wing and with a very striking broad blue-grey suffusion over the bases of both wings; inferior red spots (two) present or absent. Finally, in the third section, the sexes are different, the males being blackish-brown with general grey irroration; while the females are brown, with a pink or red bar in the fore-wing, having a basal grey suffusion in the former case, and none in the latter; inferior red spots (two) present or absent. There is obviously no mimicry of *H. melpomene* in the first section; neither can its occurrence, so far as concerns the upper-side, be reasonably claimed in the second. For although the red bar in the fore-wing may be urged as a mimetic character, this is rendered highly improbable by the presence of the striking basal pale marking, which, with the black ground-colour, gives the insects a totally different appearance. It is only in the third section that we find any real mimicry, namely, in the females of *charops, venezuelana* and *peruviana*, the last two being probably only local races of the first. These forms being brown and having lost all traces of the pale suffusion, do very convincingly suggest the existence of a close mimetic association with *H. melpomene*. Here, if anywhere, there should be evidence of reciprocal mimicry; but unfortunately for the hypothesis *charops* happens to be one of the species of *Pereute* which does not possess any red spots at all on the under-side, and this fact alone renders it highly improbable that the spots of *melpomene* are diaposematic. It appears even open to doubt whether they have any real mimetic value at all. In *Pereute* they occur most markedly in the more primitive, and apparently non-mimetic, *telthusa*, and yet they have actually been lost in *P. charops*, although it closely mimics a *Heliconius* in which they are present. How then can we consider that these spots are so important that they have been modified in *melpomene* by the influence of the very different *P. leucodrosime* (belonging to section 2), especially when it is noted that they differ considerably both in number and position in the two species? Further, if their mimetic value is so

great, how can we explain their absence in *P. callinice* which in other respects so closely resembles *P. leucodrosime*? A general contemplation of all the facts must, I think, inevitably lead to the conclusion that these red spots have been quite independently developed in *Heliconius* and without any Pierine influence whatever.

II. *The under-side red spots in the Pierine,* Archonias tereas, *and* Papilio zacynthus.

This case was originally put forward in conjunction with the preceding one, and will be found under the same references. For various reasons it is advisable to treat it separately. The line of argument in favour of Diaposematism is quite similar, it being contended that though the Pierine has evidently mimicked the Papilio in all its principal characters, yet in the case of the red spotting of the under-side the influence has been in an opposite direction.

We may first consider the red markings in *Archonias.* The genus falls into four sections, so far as mere pattern is concerned. The first section comprises a single species, *theano,* which evidently represents the more primitive colouring of the genus. Its upper-side is dark brown, with vague whitish markings, while the under-side presents a very characteristically Pierine appearance, being yellowish or whitish with a broad white-spotted dark border and the nervules broadly darkened; a colour scheme which continually reasserts itself in various genera of Pierinæ in all parts of the world; finally the basal red spots are conspicuous by their absence. The second section contains species which mimic various Ithomiinæ, and in all of them the red spots are wanting. The species of the third section mimic certain *Aristolochia* Papilios and these gradually merge into the fourth section which has developed *Heliconius*-like colours. In these last two sections the species all exhibit two red basal spots below, though these differ in position from those of *Pereute.* In the latter the spots are situated obviously on the wing, while in *Archonias* they are placed on the extreme edge of the base and on that portion which is bent against the thorax, so that they appear, unless closely examined, to be

actually on the thorax itself. When we turn to *P. zacynthus* and its allies we find that they have no red spots on the wing, but only on the thorax; a condition which is highly characteristic of *Papilio*, but which never occurs, so far as I am aware, in any Pierine. At first sight it might appear as if this furnished good evidence as to *Archonias* having mimicked the *Papilio* in this respect, especially as the most primitive species has no red spots at all. But this view is rendered less probable by the occurrence of similarly placed markings in various non-mimetic species of *Catasticta* and other closely allied Pierine genera. On the other hand, Dr. Dixey advocates the opposite view, namely, that the Pierine has influenced the *Papilio*. But a consideration of the prevalence of these red spots in the latter genus shows that this suggestion is even less probable than the other.

In Rothschild and Jordan's revision of the American Papilios (Nov. Zool., 1906, p. 435) these insects are divided into three sections. The first of these, the *Aristolochia* Papilios, again fall into four groups. Now the first three groups contain no less than 45 species every one of which has thoracic spots like those of *P. zacynthus* (which belongs to the third group), although many of the species have no mimetic relations with any Pierines. In the fourth group the red spots are replaced by yellow or white, except in the case of *polydamas* and its numerous races, in which the spots are red and there is in addition a red spot at the base of the hind-wing. Again, basal red-spots on the hind-wing are to be found in a considerable number of American Papilios belonging to Section III, in which there can be no question of Pierine influence. If we turn to the East we find a precisely similar state of affairs, namely, numerous species of quite differently coloured Papilios, including most of the splendid Ornithopteras, which have developed either red spots on the thorax, or on the base of the hind-wing (sometimes to a very remarkable extent), or on both. He who will be at the pains to investigate these facts for himself must, I think, unhesitatingly reject any argument for Diaposematism in this particular instance. The evidence in favour of an entirely independent development by the Papilios of these distinctive markings appears to be overwhelming.

III. *Why do both sexes of* Archonias tereas *mimic only the female of* Papilio zacynthus?

A second argument for Diaposematism has been based on these same two species, considered from a somewhat different standpoint. The case was stated as follows: "So far as I am aware no explanation has yet been offered of the fact that it is the females and not the males of *Papilio polymetus, P. zacynthus*, etc., that are resembled by *Euterpe tereas* and *E. critias*; whereas the males, which display brighter colours, afford at least as good, if not better, models for imitation. I would suggest that this is really due to 'reciprocal mimicry.' The protection gained by the resemblance between the Pierines and the Papilios is not all on the side of the Pierines, but mutual; and the female Papilios have, as is usual, felt the need of it more urgently than the males. For this reason the female Papilios have been led to meet the Pierines by discarding, or at any rate by not adopting, the bright metallic-blues and greens that ornament the other sex." (Trans. Ent. Soc. 1894, p. 298, note.)

The colour of the ♂ *P. zacynthus* differs principally from that of the ♀ in that the posterior two-thirds of the fore-wing patch is covered with metallic-green or blue scales, only the anterior portion being white; whereas in the ♀ the whole patch is white. The contention for reciprocal mimicry here centres entirely on the supposition that it is difficult otherwise to explain why the *Archonias* have not acquired the metallic patches of the male Papilios. In considering this difficulty the first point which suggests itself is to examine the occurrence of metallic colours in other American Pierines. This inquiry reveals the interesting fact that not a single one of these has developed any metallic colours. The same limitation holds good in Asia, as Wallace long ago pointed out, in his classical paper on the Eastern Pierines: "The metallic blue of *Morpho* and of the Lycænidæ, and the rich green of various shades which occurs in most other groups of butterflies are entirely absent" (Trans. Ent. Soc., 1867, p. 301). In fact, so far as I have been able to ascertain, it is only in Africa that any Pierines have developed such metallic scaling, and there it is confined to the males of only two or three species of *Teracolus*. But I cannot find that any Pierine mimic has ever produced this type of

colouring. In these circumstances the supposed difficulty in regard to *Archonias* evidently vanishes. It is no longer remarkable that it has not developed the metallic effects of the ♂ *Papilio*; indeed it would be much more remarkable if it had actually done so. The mimicry has simply followed the line of least resistance, and is in every way consistent with the interpretation of a simple Müllerian approach. It is possible that a fuller knowledge of the habits of the insects would throw more light on the matter; for I note that Wallace mentions that in several species of this group of *Papilio* the sexes do not inhabit the same stations (Trans. Ent. Soc. II, 1854, p. 255).

Another point raised by Dr. Dixey, in support of his interpretation that the *Papilio* has been influenced by the Pierine, is Müller's statement (Proc. Ent. Soc. 1879, p. xxiv) that in the Santa Catharina district of Brazil *Pap. nephalion*, which there represents the model, was comparatively scarce while *Arch. tereas* was common. But in the same paper (p. xxv) Müller has expressly uttered a warning against any such deduction from his statement: 'Thus the black *Archonias tereas*, with the white spots on the margin of the fore-wings and the rose-red of the hind-wings, presents a strange appearance among its congeners, whilst *Papilio nephalion* belongs to a long series of similarly coloured species, so that where this *Papilio* is rare and the *Archonias* common, we cannot for this reason regard the latter as the model of the former." Unfortunately Müller does not mention whether he had observed any other species of the numerous *zacynthus*-like Papilios in Santa Catharina, for this would be of great importance in interpreting the facts. It remains however that all local observers are agreed that the type of colouring exhibited by *zacynthus* is the most characteristic, abundant and dominant *Papilio* pattern in Brazil, and perhaps in Tropical America; nor do any species which I have seen show the least sign of having been influenced by *Archonias*. It may be noted that the mimetic forms of these Pierines persistently retain a characteristic *Archonias* marking, namely, a pale costal streak on the under-side of the hind-wing. Now, if they had really exercised a strong influence on the colouring of the Papilios as suggested, it seems only reasonable to suppose that we should find some effect produced by this characteristic stripe. But no trace of it can be seen either in *P. nephalion* or any other species of the

æneas and *lysander* groups that I have examined. Finally, there does not seem any reason to suppose that in these Papilios the females represent a modification of the male colouring. On the contrary, it appears far more probable that the female pattern is the older, and that the metallic patches of the males are a later development; indeed there are several allied species in which they are non-existent.

IV. *The suggested reciprocal resemblance between* Pieris locusta *and* Heliconius cydno galanthus.

In Trans. Ent. Soc. 1896, p. 72 (note), Dr. Dixey suggested tentatively that *P. locusta* ♂ was a mimic of *Heliconius melpomene*, so far as the under-side of the hind-wing was concerned. In Trans. Ent. Soc. 1897, p. 325, this idea was abandoned, and the very different *H. cydno galanthus* was then definitely proposed as the model. The resemblance however is certainly not of a kind to carry general conviction. The most characteristic feature of the under-side of the *Heliconius* consists of two curved chestnut stripes right across the hind-wing, having their origin at the middle of the inner margin. There is no trace of this marking in *P. locusta*, nor, so far as I am aware, does it occur independently in any American Pierines, although its appearance is simulated in several mimetic species by a prolongation of the lowest basal red spot. But the main point at issue is the contention that "there is more reason to suppose that the *Heliconius* has adopted certain features from the *Pieris* (for example, the whiteness of the ground-colour, and the disposition, if not the existence, of the basal red marks) than that the converse alone has taken place" (*l. c.* p. 327). The reasons in support of this belief are not mentioned, but we have seen above that the contention that the red basal spots have been produced, or even materially affected, in *Heliconius* by Pierine influence cannot be reasonably sustained. It remains only to deal with the proposition that the white area on the under-side of the fore-wing in the *Heliconius* must be explained by its having directly mimicked the Pierine. Now the very position of this white patch is of itself a serious difficulty in the way of such an interpretation. The marking can have no significance during flight, for on its upper-side *P. locusta* ♂ has not the slightest resemblance to the

Heliconius, being an ordinary plain white insect with a moderate black border. On the other hand, in a position of rest this marking would be concealed, and it is therefore difficult to understand what mimetic value it could have. But it is only fair to point out that when the above proposal was made the true ♀ of *P. locusta* was not known, the ♀ figured by Dr. Dixey (*l.c.* Pl. VII, fig. 7) belonging really to *P. tithoreides,* Butl. Now the real ♀ of *locusta,* which is evidently a rare insect, does present a fair general resemblance on the upper-side to *H. c. galanthus.* For the whole of the hind-wing and the basal part of the fore-wing have been very much darkened and thus present a likeness to the similar dark blue areas in the *Heliconius.* We need not therefore labour the point as to the mimicry of *locusta* ♂, but may merely consider whether it is reasonable to suppose that the white patch on the upper-side of the fore-wing of *H. cydno* and its numerous varieties has been produced by their directly mimicking *locusta* ♀.

The first point is the question of unpalatability. In the cases previously discussed there do appear to have been reasonable grounds for suggesting that the Pierines involved were distasteful. Here there appears to be none. Thus *à priori* it seems extremely doubtful that a scarce ♀ Pierine, of questionable unpalatability, should have been able to profoundly modify the colouring of both sexes of an undoubtedly nauseous and abundant species such as *H. cydno.* The crux of the whole argument lies in the assumption that white colouring is abnormal in *Heliconius* and must therefore be due to Pierine influence. Now Riffarth and Stichel recognise 9 sub-species and 5 subsidiary forms of *cydno.* Of these 7 have a conspicuous broad white border in the hind-wing; 3 have this border of a yellow colour, and 4 (including *galanthus*) have no distinct border at all. It seems probable that the borderless *galanthus*-like forms represent the older type, of which the much commoner pale-margined forms are a more recent development. The hind-wings of these latter insects are quite different from anything to be found among American Pierines, and it can scarcely be contested that these broad white margins have been developed by *Heliconius cydno* and *sapho* quite apart from Pierine mimicry; and they have again been independently produced in the very different *H. cyrbia.* Further we may note that in Guiana *H. hecale* presents a large white area in the fore-wing;

while other species of this inordinately variable genus exhibit forms having white patches or bands in the fore-wing. Of these may be mentioned various forms of *sapho*, *xenoclea-notabilis*, *anderida-albicilla*, *antiochus-antiochus*, *wallacei-wallacei* f. *elsa*, *wallacei-colon* f. *clytia*, etc., while in such forms as *doris-doris* and *erato-erato* f. *udalrica* the conversion of the yellow discal patch into white crops out as an occasional variation, thus showing an inherent tendency in that direction.

There seem therefore no real grounds for believing that *Heliconius* cannot develop white markings, except under pressure of external mimetic influence, and the most satisfactory interpretation of the present case is that the ♀ *Pieris* is a simple Batesian mimic of the *Heliconius*.

V. *The suggested reciprocal resemblance between the African Papilios of the* zenobia *group and the Acræine genus* Planema.

The normal upper-side colouring of the Papilios of the *zenobia* group may be briefly described as black, with a continuous whitish or yellowish oblique stripe across both wings, which varies in width, and often becomes macular in the fore-wing. There are 12 species recognised by Aurivillius, of which 5 present this type of colouring in both sexes, while in the remaining 7 the female is mimetic of either a *Planema* or an *Amauris* of the *echeria* pattern. In both sexes of all the species there is on the under-side of the hind-wing a large basal triangle of a golden-brown or chocolate-brown colour. In the largest species, such as *cypræofila* and *gallienus*, in which the females are non-mimetic, this triangle attains its greatest size, and is traversed by continuous black inter-nervular streaks. In the mimetic species, as well as the non-mimetic *zenobia*, the streak nearest the costa is broadly divided so as to form two spots. In the females of the mimetic section the brown area is more reduced, causing a considerable shortening of the black streaks nearer the inner margin, and thus producing a more spot-like appearance. In this condition the marking presents an obvious superficial resemblance to the brown, black-spotted area which is found on the hind-wings of so many Planemas. This resemblance has been generally explained as being due to the Papilios being Batesian mimics of the Planemas,

whose unpalatability is well established; a view which is still strongly held by Mr. Trimen. But this idea has been traversed by Prof. Poulton (Trans. Ent. Soc. 1902, p. 488), who claims that the brown triangle is more characteristic of, and more highly developed in, the Papilios than the Planemas. He therefore assumes the Papilios to be unpalatable, and suggests that it is their mimetic influence which has produced the brown triangle in *Planema*; and then subsequently the process has been reversed and the Papilios have begun to mimic the Planemas by a partial conversion of their stripes into spots, this being described as "a late diaposematic response" (*l. c.* p. 489).

Although this suggestion is supposed to indicate a case of diaposematism, it is clear that the interpretation is not really diaposematic, in the sense of suggesting a mutual simultaneous approach. On the contrary, it evidently comes under the heading of what I have termed (p. 103) Alternating Resemblance, and involves the assumption of a corresponding alternation in the individual numbers of the respective species.

The main point at issue is whether these Papilios are really unpalatable, and of this there is no practical evidence. It can only be settled by direct experiment, and by careful observation of the insects in relation to their environment. Personally, I have had experience of only a single species of the group, namely, the extremely local *P. echerioides*. The general behaviour of this insect appears to me to be entirely at variance with the supposition that it is endowed with nauseous qualities, but its habits suggest a possible interpretation of the facts under discussion. In South Africa *P. echerioides* is essentially a forest insect; it is not to be found in open woodlands, but only among dense and heavy timber, coursing irregularly over the undergrowth beneath the trees. In such an environment, lit up by splashes of broken sunlight, the under-surface of the butterfly, as it settles on some low shrub or among dead leaves on the ground, exhibits none of the conspicuous warning characters which have been attributed to it; on the contrary, its colours harmonise most effectively with the surroundings in which it spends most of its time and in which it habitually goes to rest.

The habits of our only *Planema*, *P. aganice*, are very different. For although it is also a lover of forests, it does not fly beneath the trees, but is to be found sailing about

the clearings round the edges of the forest patches; and when it settles there is no attempt at concealment, but it hangs limply from the end of a leaf or bare twig in the full sunlight. In such circumstances the same colour scheme, which in the *Papilio* makes for concealment, becomes conspicuous and obtrusive. But it may be asked, if their habits are so different, how can it benefit the *Papilio* to mimic the *Planema*? The question of food-supply furnishes the answer. In the forest itself flowers are few and far between; they are lovers of sunlight and are to be found principally in the clearings and round the edges of the forest. To such places the *Papilio* resorts to feed; it is here that it comes into contact with the *Planema*; it is here that the forces which make for mimicry find scope to operate.

There seems reason to believe that the Central and West African Papilios of this group have habits similar to those of *echerioides*. The group has probably originated in West Africa and spread thence East and South. The larger species, *cypræofila* and *gallienus*, with non-mimetic females, appear to be the least modified members of it, judging by their outline and colouring. The large brown triangle of these species, with its unaltered *Papilio* streaks, may then represent a scheme of *cryptic* coloration independently evolved by the group. The roughly *Planema*-like appearance of this pattern would of itself determine a mimicry of *Planema* wherever any species of the group came into special contact with that genus. The resemblance would be enhanced by the breaking of the stripes into spots, and by the reduction in size of the brown triangle, so that it would become, as we see it, smaller in the mimetic female than in its non-mimetic male. That this progressive diminution has actually taken place seems to be confirmed by a very interesting form of *Papilio cynorta* from Uganda, recently described by Mr. Neave under the name *peculiaris* (Nov. Zool. XI, p. 342, Pl. I, f. 7). According to Dr. Jordan (Trans. Ent. Soc. 1906, p. 219, note) the males are hardly distinguishable from the typical Western *cynorta*. But whereas the female of that form mimics *Planema gea*, and has a conspicuous brown triangle, *peculiaris* mimics *Pl. paragea*, in which the basal triangle is almost obsolete. As a result we find that in the *Papilio* the triangle has been reduced to very small dimensions, all the stripes have disappeared

from it and only the round spot above the cell is left. Here, at least, it is clear that, so far as concerns the brown patch, it is not the *Papilio* which has influenced the *Planema*, but *vice versa*.

A final point may be noticed. On the West Coast the genus *Planema* attains its greatest development and the *echeria* type of *Amauris* is absent; the mimetic *zenobia* Papilios therefore all mimic *Planema*. In East and South Africa where *A. echeria* and *albimaculata* occur with *Planema*, the Papilios have abandoned the latter and mimic the *Amauris*; the reason being, no doubt, that the *Amauris* are much less particular as to the stations which they frequent and are to be found commonly flying right in the shady forests where the Papilios live. The facts appear to fully support Mr. Trimen's view that with these Papilios the earlier tendency was to mimic *Planema* and that they have later been diverted towards *Amauris* (*cf.* Trans. Ent. Soc. 1902, p. 488).

VI. *The suggested diaposematic resemblance between the two Eastern Pierines* Huphina corva *and* Ixias baliensis, ♀.

This suggestion was made by Dr. Dixey in a short paper in Trans. Ent. Soc. 1906 (p. 521, Pl. XXXI). He there calls attention to the fact that *H. nerissa corva* differs from the typical *nerissa* of Continental India in the greater width of the black border on the hind-wings. This it is suggested is a mimetic approach towards the ♀ of *Ixias baliensis*, which is only a slight local modification of *I. reinwardtii*. But so far as concerns the fore-wings, *I. baliensis* has departed from the normal colouring of ♀ *Ixias* by the development of a row of four whitish submarginal spots in the apical black area. In this case it is claimed that the *Ixias* has mimicked the *Huphina*, so that there has been a reciprocal mimetic interchange.

This interpretation involves the assumption of unpalatability in both the species. My friends, Colonel C. T. Bingham, Colonel N. Manders and Mr. R. Shelford, who are all acquainted with both genera in the field, inform me that while the Huphinas certainly exhibit a slow flight and a general demeanour which would suggest the possession of unpleasant qualities, such is by no means the case with the species of *Ixias*, which are active and wary insects. This fact, taken in conjunction with the obviously procryptic

under-side colouring which prevails in that section of the genus to which *I. baliensis* belongs, renders it very improbable that the *Ixias* has in any way influenced the *Huphina*. Furthermore, so far as the ♀ sex is concerned, the increase of the black border in the hind-wing of *H. nerissa corva* is not particularly striking, and there are two females in the British Museum which in this respect are scarcely to be distinguished from a ♀ *nerissa* from Sikkim. It is in the ♂ that the increase is specially noticeable, and this sex can certainly not be reasonably regarded as a mimic of *I. baliensis* ♀, for the entire absence of the heavy black bar across the cell of the fore-wing gives it a very different appearance.

Another serious difficulty, to which Dr. Dixey has himself referred, is the discrepancy in the geographical range of the two species. To meet this it is suggested that either *H. corva* has extended its range, or *I. baliensis* has contracted its range, subsequently to the production of the mimicry. The facts do not appear to justify either of these assumptions. Dealing first with the *Huphina*, we find that the continental form *nerissa* (with its var. *phryne*) is represented in the Andamans by a slightly darker form, *lichenosa*, leading up to the broad-bordered race *corva* (including the scarcely separable *sumatrana*) which is found throughout Sumatra, Java and up to the islands of Bali and Lombok. On the other hand, so far as we know at present, the range of *Ixias reinwardtii* lies entirely to the east of this, namely, in the islands of Timor, Flores, Sumba, Sumbawa, Lombok, up to Bali, which constitutes its westernmost limit.

If we assume *H. corva* to be a mimetic modification of *nerissa* which was evolved in the island of Bali and has since extended thence, we must suppose that originally typical *nerissa* occurred throughout Sumatra, Java and Bali. If this were so, why should *corva* have so totally replaced *nerissa* in Java and Sumatra, where *Ixias baliensis* does not occur, and how are we to explain the existence of an intermediate form in the Andamans? On the other hand, there is even more difficulty in accepting the supposition that *I. reinwardtii baliensis*, which is confined to a little island some 80 by 50 miles in extent, should have originally ranged throughout Java and Sumatra (with a combined length of some 1,700 miles), from which it has now completely disappeared. For the

slight characteristics which distinguish *baliensis* from the typical race *reinwardtii* are essentially such as we should expect to find in a group of individuals which have been comparatively recently isolated from the main body of the species; in other words, *baliensis* differs from *reinwardtii* simply because it has been confined to the island of Bali.

If we examine such a series of forms as *Huphina phryne, nerissa, lichenosa* and *corva*, it seems clear that we are dealing with those progressive modifications which are generally comprised under the name of geographical races; that is to say, the differences exhibited are accepted as due to the influence of either climatic causes, or isolation, or a combination of both. It is the more probable that such is here the case when we find that the allied Indian *H. nadina* ♂ presents similar modifications; being represented by an intermediate form, *andamana*, in the Andamans, and a more heavily-bordered form, *fawcetti*, in Sumatra. Such progressive widening of the black borders may also be observed in other Pierine genera, such as *Delias, Prioneris, Appias*, etc.; while from Africa, and doubtless from many other parts of the world, numerous parallel cases could be cited in which no mimetic interpretation could cover the facts.

Further, it may be mentioned that heavy black borders are a very common feature in the genus *Huphina* and exist in a majority of the species occurring in the Malay Archipelago. They attain their highest development in *affinis* (Celebes), in which they occupy nearly half the wing and are far broader than anything to be found throughout the whole genus *Ixias*. A considerable number of species from these islands could be mentioned in which the borders are markedly better developed than in *H. corva*.

I find myself unable therefore to accept the suggestion that the broader black margin of *H. corva* is due to the direct mimetic influence of *I. baliensis* ♀. It is possible that the *Ixias* may have mimicked the *Huphina*, but in dealing with such black and white Pierines a hasty assumption of mimicry is specially to be deprecated; and it is well to bear in mind the judicious warning in this connection uttered by Wallace forty years ago: "By far the most general type of colouring in the Pieridæ, and which recurs in hundreds of species, is a white ground with a black outer border, always most developed at the

apex of the upper-wings, and very frequently less marked on the hind-wings. It is not therefore surprising that among the many slight modifications of this commonest and most simple type of coloration, two species belonging to different genera should closely resemble each other externally" (Trans. Ent. Soc. 1867, p. 311).

Finally, it may be mentioned that very little is known about the ♀ of *I. baliensis.* This sex was not known to Frühstorffer when he described the subspecies in 1897. There is a single specimen at Oxford, namely, that captured by Mr. Shelford and figured by Dr. Dixey (*l. c.*), and only one in the British Museum. The latter differs considerably in appearance from the Oxford ♀, in that it has a pronounced suffusion of yellow in the fore-wing and a reduction of the black markings; it can in no sense be regarded as a mimic of *H. corva.* There is no evidence available as to the relative occurrence of these two forms.

VII. *The suggested reciprocal mimicry between* Papilio dardanus ♀ *form* cenea *and the Danaines* Amauris echeria *and* albimaculata.

The remarkable suggestion that these two dominant species of *Amauris* have been modified in mimicry of *P. dardanus* was propounded by Professor Poulton in Trans. Ent. Soc. 1906, p. 292, and the following comments will be better understood if reference be made to the numerous plates with which his paper is illustrated.

On examining some of the more primitive females of *P. dardanus* (such as *trimeni, l. c.* Pl. XVIII, fig. 1), Professor Poulton was struck by the outward production of the basal pale patch of the hind-wing between veins 5 and 6, a character which is readily recognisable in the non-mimetic ♂. Now, in *Amauris echeria* and *albimaculata* the discal pale patch also shows a very marked external angulation at about the same position; but it is contended that this form of marking cannot have been acquired from the *Amauris* by the *Papilio,* because it is ancestral in the latter species. The conclusion is therefore reached that the *Amauris* must have acquired it by mimicking the *Papilio,* and subsequently exaggerated the character. The possibility of independent origin is not considered.

This suggestion invites criticism along three lines: the question of the edibility of the *Papilio*; the relative

numbers of model and mimic; and an examination of the occurrence of the angular markings in the species allied to the *Amauris* and *Papilio* respectively.

With regard to the inedibility of *dardanus*, unfortunately no experiments have been made with this species,* although Mr. Mansel Weale has observed the ♂ to be captured and eaten by a flycatcher (*Terpsiphone perspicillata*) in Cape Colony (Proc. Ent. Soc. 1874, p. 132). But my own observations of the general habits of the species in its natural haunts cannot permit me to regard it as an unpalatable insect, as I should apply that term to an *Acræa*, *Mylothris* or *Neptis*; and that very accurate observer, Mr. R. Trimen, F.R.S., informs me that he is strongly of the same opinion. He was particularly impressed by the fact that the ♀ shows a persistent habit of concealing itself beneath the herbage when not actually searching for food; a habit also noted by the late Colonel Bowker and Mr. Mansel Weale. This behaviour is in striking contrast to that of all S. African species having undoubted nauseous qualities. Again, no one who has seen the ♂ *dardanus* at rest can doubt the cryptic value of its underside colouring, and Mr. Trimen has quoted an observation of the late Mrs. Barber showing the care exercised in selecting a suitable resting-place (S. Afr. Butt.; iii, p. 254),† another habit which is quite at variance with the assumption of inedibility. Finally, when we examine the more primitive and non-mimetic females of the Abyssinian *P. antinorii* and the Madagascan *P. meriones*, from which *dardanus* is derived, we find that their under-sides are also thoroughly cryptic in character. Thus the balance of evidence certainly appears to be against the supposition

* Drs. Dixey and Longstaff record that the ♂ had a similar smell to that found in *P. demodocus* and described as "like fusty packing-straw," but in *dardanus* it was "less musty." The ♀ was not investigated, so that it is not certain that this odour may not be merely sexual in character, like the musky odour of male hawk-moths mentioned by Darwin ("Descent of Man," p. 308). It may be noted however that a ♂ *Pap. leonidas* examined by Dr. Dixey was considered to have the unpleasant smell of *D. chrysippus*; whereas several males smelt by Dr. Longstaff were found to give a "strong, sweet, 'white flower' scent, followed by something more spicy." A similar discrepancy occurs in their records as to *Neptis agatha* (Proc. Ent. Soc. 1906, p. v). The exact significance of the observations therefore remains doubtful.

† A similar observation has been made by Surgeon-Major Clements at Sierra Leone (*cf.* Proc. Ent. Soc. 1906, p. xxix).

that *dardanus* possesses nauseous qualities; and if this be so, the argument for Diaposematism falls to the ground.

It is not always easy to form a definite conclusion as to the relative numbers of a model and its mimic, but there can be little chance of error in the present instance. We may first note that if the ♀ *dardanus* exhibits this angular marking in such of its forms as *hippocoonoides* or *trophonius*, this can have no mimetic influence upon *A. echeria*, because those forms do not at all resemble this species, but mimic two other Danaines. For this reason we must only consider the occurrence of this angulation in the *cenea* form which mimics *echeria*. We shall find however that that character occurs more rarely in *cenea* than in the above forms, and then nearly always in the examples which are least like *echeria*. Therefore in estimating numbers, we have on one side a comparatively rare variation of a single form of only one sex of the Papilio, and on the other side both sexes of two very common species of *Amauris*. From what I know of the prevalence of these two insects in nature it would be a conservative estimate to reckon that the latter would exceed the former in the ratio of 100 to 1. It has already been shown how impossible it is to believe that in such circumstances the mere operation of the Müllerian factor could have compelled the *Amauris* to mimic this variation of the *Papilio*. Here again the facts appear to entirely forbid a diaposematic interpretation.

When we investigate the occurrence of this angular marking in other species of *Amauris* and *Papilio*, still further difficulties present themselves. With one or two exceptions all the species of *Amauris* have a large basal or sub-basal pale patch on the hind-wings. Out of 20 of such species I find that no less than 13 possess the angulation in question. In *psyttalea* and *dominicanus* it is variable in its occurrence; in such forms as *lobengula* and *crawshayi* it is very similar to what we find in *Pap. dardanus*; in *ochleides*, *hyalites*, etc., it is more marked; whilst in *echeria* and *albimaculata* it is far more developed than in any *Papilio*. On the other hand, this character is a very unusual one in the genus *Papilio*; indeed I have failed to find anything which is really comparable with the *Amauris* pattern except among those Papilios which tend to mimic Danaines in which it already exists. These facts, again, are quite at variance with what

we should expect to find if the argument for reciprocal influence were sound.

It is by no means evident that this angular marking has any real mimetic significance at all. In the more primitive and non-mimetic ♀♀ of *Pap. meriones* and *antinorii* the hind-wing is usually pale yellow, with three large, disconnected, submarginal black patches. The first step in the mimetic approach towards the Danaines appears to have consisted in the linking up of these patches to form the continuous dark border so characteristic of the models. An examination of the various forms of the ♂ *dardanus* shows that the costal and median black patches usually unite in a very characteristic manner, so as to give rise to the angulation in question; and we may reasonably assume that a somewhat similar process took place in the females. Now, it will be found that the development of the angle is fairly constantly correlated with a comparatively narrow black border, and therefore it occurs most frequently in the more primitive and less specialised mimics, such as the forms *trimeni* and *hippocoonoides*, in which the border is not broad. On the other hand, as the inner edge of the border tends to approach the apex of the discoidal cell, so does the angle become more or less completely obliterated. In *Amauris echeria* and *albimaculata* the black border is very broad, and it will be found that the specimens of *P. dardanus* f. *cenea* which present the closest resemblance to them are those in which the border is very broad and the angle consequently obliterated (cf. Trans. Ent. Soc. 1906, Pl. XVII, figs. 8–10, as against fig. 11, which is a comparatively poor mimic).

So far therefore from being able to accept the suggestion that the angular marking has been produced in the *Amauris* by the influence of the *Papilio*, it appears to me that this merely transitional character in the *Papilio* has had so little mimetic value that it is actually in process of being eliminated by the influence of the *Amauris*.*

* It is interesting to note in this connection that neither *Papilio echerioides* nor *P. jacksoni* has developed this angulation, although they are excellent mimics of the same two species of *Amauris*.

VIII. *The mimetic relationship between the Danaine* Melinda formosa *and* Papilio rex.

This point has been discussed by Mr. S. A. Neave in Trans. Ent. Soc. 1906, p. 216 (*cf.* Pl. XI and XII), where he advances the proposition that *Pap. rex* and its local race, *mimeticus*, are not Batesian mimics of *Melinda formosa* and *mercedonia* respectively, but that they are themselves unpalatable insects, which have in some respects mimicked the Danaines, in others served as models for them.

There is no tangible evidence as to the existence of nauseous qualities in these Papilios; it is merely deduced from the supposed reciprocal nature of the mimicry. According to our present knowledge these are very much rarer than the Melindas; indeed, in the case of *mimeticus*, I am not aware of the existence of any specimens beyond the unique type from Uganda, although its suggested mimic is stated by Mr. Neave to be common in that district, and is also recorded from a good many localities in German East Africa.

The foundation of Mr. Neave's argument consists in the assumption that the three species of the African group, or sub-genus, *Melinda*, have been directly derived from *Tirumala petiverana*, which is the African representative of the two common Asiatic species *T. limniace* and *septentrionis*.

Now, the Melindas differ from *petiverana* in having the fore-wings considerably more elongated, and also in having the pale markings at the base of the hind-wing more consolidated, so as to form a continuous pale area, interrupted only by the darkened nervures. These are therefore stated to be "new developments and non-ancestral characters" which have been acquired by the Danaines from *Papilio rex*.

But the validity of this suggested genealogy seems open to serious doubt. The fact that *T. petiverana* represents merely a recent modification of some Eastern *Tirumala* is so clear that it is generally treated as only a local race of *T. limniace*. On the other hand, the Melindas differ from the true Tirumalas not only in the structure of the ♂ brand (upon which Moore founded his genus), but also in several characters in the ♂ genitalia, as well as their general facies. There is no species of *Melinda* in Asia, and these differences appear to indicate that the African forms have been isolated

for a very considerable time from the Eastern Tirumalas. We have therefore no reason for assuming that the obviously recent intruder, *T. petiverana*, must have been the direct progenitor of the Melindas.

The more recent intrusion of *petiverana* must also be inferred if we apply Professor Poulton's test, namely, a comparison of the mimetic effect produced by the respective forms. In spite of its abundance and widespread occurrence in Tropical Africa *petiverana* has not yet succeeded in producing a really close mimic, though there are two or three species which present a generalised resemblance to it; whereas all three Melindas have entered into a very close mimetic association with some particular species, thus indicating that they have been resident in the country for a longer period.

There seems to be no justification for assuming that *Melinda* has been directly derived from any particular species of Asiatic *Tirumala* as we now know it. But with regard to the pale patch in the hind-wing referred to by Mr. Neave, we may note that it occurs in several Eastern Tirumalas, such as various forms of *limniace* and *melissa, choaspes*, etc.; its appearance being very similar to what we find in *M. formosa.* Wherefore the statement that this character must be a "new and non-ancestral development" in the last species cannot be reasonably maintained. Moreover, this type of marking is very common among Asiatic Danaines and is particularly characteristic of the African forms.

As to the pointed fore-wing of *M. formosa*, it is true that no *Tirumala* exhibits a similar shape; but this again is far from being an unusual character among Eastern Danaines, and in the genus *Nasuma* it has attained an even greater development than in *Melinda.* An elongated fore-wing is also a very common feature among the African species and is to be found in a considerable number of *Amauris.* It is by no means clear why these slow-flying butterflies should have so largely adopted this pointed form of wing; but it seems not improbable that the cause which has produced this effect in *Amauris* has also operated on the Melindas during their prolonged isolation from their Eastern progenitors. This view is indirectly supported by the following facts.

Mr. Neave has pointed out that in the Abyssinian subspecies *M. formosa neumanni* the fore-wings are slightly

shorter than in the typical form. This is exactly paralleled in the Abyssinian *Amauris hecate stictica,* which has the fore-wing very distinctly shorter than in the Western *hecate*; and again examples of *A. echeria streckeri* from the same locality have these wings appreciably less pointed than in *A. echeria jacksoni* from British East Africa. Neither can there be any question as to mimetic influence between these three very different species. We are therefore justified in assuming provisionally that the shape of the wing is affected by some general local factor.*

It has been suggested by Mr. Neave that *M. formosa neumanni* represents an intermediate stage between *M. formosa* and *T. petiverana*; but he then had only a single example of *neumanni* at his disposal. Dr. Jordan has very kindly brought up to London for my examination three typical specimens of this Abyssinian form, and he entirely agrees with me that there are no adequate reasons for accepting this suggestion, the improbability of which has already been shown on other grounds.

The attempt to interpret the mimicry in this case as being reciprocal does not appear convincing, while the facts are entirely consonant with the conception that the *Papilio* is a simple Batesian mimic of the *Melinda. P. rex* is a very isolated species and has evidently been profoundly modified by mimetic influences. But its structural characters, in conjunction with the characteristic arrangement of the submarginal row of yellow spots, indicate that its nearest ally is *P. demodocus,* which has the fore-wings much less produced. It is probable therefore that *rex* represents a mimetic modification of some *demodocus*-like ancestor.

My friend Mr. Trimen has kindly permitted me to quote the following comments which he has sent me in connection with this case: "The latter feature [elongation of fore-wing] strikes me as affording extremely weak support to that theory [reciprocal mimicry], seeing that, next to the showy and strongly-contrasted colours on both upper and under surfaces of the wings, there is no feature so

* Wallace has recorded ("Malay Archip." p. 215) that there is a similar tendency in the Island of Celebes for butterflies of different genera and subfamilies to develop a markedly pointed or elongated wing. It may be noted that *Amauris comorana,* in the Comoro Islands, has a sharper fore-wing than any continental species, being in this respect very similar to *M. formosa.*

universally and saliently denoting the unpalatable groups of butterflies. It is impossible to doubt that in all these groups the advantage of the prolongation of the fore-wings is primarily to increase conspicuousness by that special form of wing, and secondly to increase the area available for warning colours. The character being so general and so fixed in tendency, one cannot be surprised to find some species developing it more than others; and there seems no need, in such a case as that of the *Melinda* Danaines, to have recourse to the far-fetched idea of these abundant and distasteful butterflies having to borrow so natural a feature from the rare *Papilio rex* and extremely rare *P. mimeticus*. In the genus *Acræa* no one deems it necessary to account for such great prolongation of the fore-wing as is found in *A. perenna* or *A. pharsalus* by assigning it to mimicry of any butterfly of a remote family."

These then are the cases which have so far been adduced to demonstrate the actual occurrence in nature of Reciprocal Mimicry. To my mind, the facts when critically examined do not lend any valid support to such a hypothesis; nor even do they appear to justify in any instance the assumption of that mimetic inter-action which I have termed Alternating Mimicry or Resemblance.

The Scope of Batesian Mimicry.

Up to the present time it has generally been considered that mimicry between two species which both possess distasteful qualities cannot possibly be explained on the lines of Bates' theory, but that the association must be Müllerian in character; in other words, that it can only have been produced by the selective action of experimental tasting by inexperienced animals. Now when I began experimenting on these subjects in South Africa, some twelve years ago, one of the first things that impressed me was the fact that there was clearly a considerable difference in the degrees of distastefulness, not only between different genera of butterflies, but even within the limits of a single genus, such as *Acræa*. Further, the question was complicated by the divergence in the likes and dislikes of various insectivorous animals. No doubt all this has long been recognised; yet in practice, the application of the Müllerian interpretation involves the assumption of a uniform standard

of inedibility, and the complications which would be introduced by inequality in this respect have not been taken into account.

When we recognise however that there actually are varying grades of unpalatability in butterflies, and that certain enemies may adapt themselves to prey on the less protected forms while avoiding those that are most nauseous, it becomes clear that any mimicry which may arise as a result of such selection could not possibly be classed as Müllerian, but would be due to the simple operation of the principle enunciated by Bates, in spite of the fact that the mimic possesses qualities rendering it distasteful to other animals. That there is no inherent improbability in such a supposition is shown by some experiments I made upon a tame ground hornbill (*Bucorax caffer*) in Natal (Trans. Ent. Soc. 1904, p. 347). To this bird, which roamed unconfined, I gave at different times five species of *Acræa* and one of *Planema,* all of which were readily eaten and with evident appreciation; but when a *Danaida chrysippus* was offered to it, it merely crushed the thorax and dropped it at once, a second specimen being treated in a precisely similar manner. Again, through the kindness of Mr. C. F. M. Swynnerton I have obtained proof that wild Bee-eaters will prey upon Acræas; there is also some evidence that they avoid Danaines. When fuller information is obtained on this point it may be necessary to reconsider the current supposition that the mimicry of *Acræa encedon* for *Danaida chrysippus* is purely Müllerian.

But there is another way in which Batesian mimicry may have arisen among unpalatable butterflies. Professor Poulton long ago pointed out that insectivorous animals which, under normal conditions, would refuse insects having an unpleasant taste, would yet eat them when driven thereto by hunger. If we suppose that in such circumstances a wild bird were compelled to feed upon distasteful insects, upon making experiments it would doubtless find that while some of these were extremely unpleasant, others would be passable. It seems an entirely fair and reasonable supposition to infer that this bird would select the species which were less unpalatable to the exclusion of the others, and if the necessary variations arose, this selection would tend to cause the former to become Batesian mimics of the latter. Such

conditions would be likely to occur very frequently during the dry winter months in South Africa. Here again I find some confirmatory evidence among my experiments (Trans. Ent. Soc. 1902, p. 344). A tame kestrel (*Tinnunculus naumanni*), which had shown pronounced dislike of both Acræas and *Danaida chrysippus*, was starved for twenty-four hours. After eating seven palatable butterflies it was given two Acræas, which were swallowed whole; then a *D. chrysippus* was offered to it, which was tasted but emphatically rejected, and immediately afterwards three more Acræas were swallowed whole. Thus under the stress of hunger the bitter juices of the Acræas were disregarded, but the more highly unpleasant flavour of the Danaine still remained a deterrent.

From these remarks we see that the interpretation of Batesian mimicry is not to be restricted only to those cases where an edible species mimics an inedible model; but while in Müllerian mimicry the essential condition is a difference in the individual numbers of two inedible species, in Batesian mimicry the essential condition is a difference in the palatability. Both species may be distasteful, but wherever there is scope for preference, there it is possible for Bates' principle to operate. Thus, so far from being able to accept the suggestion that practically all mimicry among butterflies is Müllerian in character, it seems to me that we have not yet begun to appreciate how wide a significance Bates' principle may have. The question is extremely complex, and resolves itself ultimately into a consideration of the mental attitude of insectivorous animals towards their prey. It is even possible for a single species to be at the same time both a Müllerian and a Batesian mimic of one and the same species in relation to the attacks of different enemies. The final decision on these points must rest with the field-observer and experimenter.

On the greater predominance of the factors which make for Batesian mimicry.

There are some general considerations which also appear to negative the supposition that the occurrence of Müllerian mimicry is far in excess of Batesian. It has already been argued (p. 113) that the operation of the Müllerian factor is practically restricted to the breeding season of birds,

etc., while Bates' factor is in force at all times. But if we further consider the life of an individual bird it is apparent that its experimental period is only of short duration, while for the rest of its life its selective action will be simply in a Batesian sense; its increasing experience giving it added efficacy in this direction. As against this view Professor Poulton has urged (Proc. Ent. Soc. 1903, p. ix) that Müllerian selection is probably more keen than it appears; that we must not estimate it by a comparison of the relative numbers of mature and immature enemies at any given time, but that we must remember that there is a considerable elimination of the young of these enemies, so that a large percentage never reaches maturity, and it is apparently assumed that these individuals only operate as Müllerian factors.

Taking the case of birds, which are, almost certainly, the principal agents in the production of mimicry among butterflies, let us examine this matter of the destruction of the young. We have no exact knowledge on the subject at all, but it is reasonable to suppose that the most critical and dangerous period of a young bird's life is during the time when it is a helpless nestling and also for a few days after it has left the nest, while it is still unable to fly properly, to recognise its enemies or to provide itself with food. It is probable, therefore, that by far the greatest destruction of life among young birds will take place between the time when they leave the egg and the time when they are able to fly properly and forage for themselves. But throughout this period young birds do *not* operate as Müllerian factors; such selective influence as they may have upon the insects in their neighbourhood will be exercised entirely through the medium of their parents, and as these latter will be mature and, presumably, experienced birds, their effect will be solely in a Batesian direction. This aspect of the question therefore does not, as it seems to me, add weight to the Müllerian argument, but rather the reverse.

Tenacity of life in unpalatable species.

Many observers have called attention to the fact that various butterflies exhibit a very remarkable tenacity of life, accompanied by a toughness of the integuments. In all these cases the insects belong to genera in which the

existence of nauseous qualities has been well established, and this tenacity does not appear to occur apart from those qualities. The great utility of such a faculty to insects which are liable to be experimentally seized and rejected by enemies is so obvious that its very existence may be taken as good circumstantial evidence that Müller's factor is an objective reality, and not a mere figment of the imagination. But it must not be forgotten that the very efficacy of this characteristic in saving the lives of the insects and enabling them to propagate their kind after experimental attacks (an essential condition for its development) causes it to become a serious check on the production of Müllerian mimicry; for such mimicry can be brought about only by a progressive destruction, or sexual disablement, by experimental tasting, of those individuals of the mimic which do not conform to the mimetic pattern. Wherefore any quality evolved by the species which diminishes this destruction must, so far as it is successful, prevent a mimetic approach. This limitation of Müller's conception does not appear to have been sufficiently taken into account.

Colour as a guide to unpalatability.

Although the existence of displeasing qualities in butterflies is very generally indicated by bright colours on both surfaces of the wings, such is by no means always the case. Among the *Acræinæ, Ithomiinæ,* and especially the *Euplœini,* there are many instances of colouring so sombre that were it associated with the requisite procryptic habits it would serve most effectually as a means of concealment. In such instances it is only the slow heavy flight and generally gregarious habits of the insects which cause them to become conspicuous objects; and these peculiarities of manner are to be found in every species whose distastefulness has been satisfactorily demonstrated. On the other hand, there is at present no experimental evidence which clearly proves the existence of inedible qualities in butterflies which exhibit a strong active flight and general wariness of manner, together with obviously procryptic habits. We may of course assume the existence of such qualities, but the value and desirability of such an assumption must remain merely a matter of opinion.

As a result of a good many years' experience of

butterfly life in South Africa I am convinced that we shall obtain a truer insight into the mimetic relationships of these insects if we take their natural behaviour as our guide, than if we rely too exclusively upon theoretical deductions based on colour patterns alone.

To take an example. We know nothing whatever about the edibility, or otherwise, of the numerous species of South American *Erycinidæ*. There appear to be a good many cases of mimicry among them, and a certain number of the species are very brightly coloured. It has therefore been supposed that the family is probably unpalatable as a whole. On the other hand, Wallace tells us (Trans. Ent. Soc. (2), II, 1863, p. 262) that the brightly-coloured species of *Erycina* have a very quick, jerky, "skipper"-like flight; whereas of the other genera "the great mass of the species" have the curious habit of always settling on the under-sides of leaves with wings outspread.* Now habits such as these are not known to occur among any distasteful butterflies in any part of the world; for, as we have seen, leisurely movements and a contempt for concealment are the most essential characteristics of these insects, for which the display of their warning colours is of the very first importance. In the light of our present knowledge therefore it seems difficult to justify such a far-reaching assumption of distastefulness; and we can scarce hope for stability in the theoretical edifices which may be raised on so dubious a foundation.

Again, it has been suggested that the roughly *Acræa*-like facies of the giant *Papilio antimachus* of West Africa has probably a Müllerian significance, apparently without any regard to its habits. My friend, Professor Yngve Sjöstedt, of Stockholm, who collected for some time in the Cameroons, has given me a graphic account of the great wariness and tremendous speed of this strange insect, whose flight, he said, could only be compared to that of a swallow. On the other hand, he told me that the lovely blue *Papilio zalmoxis*, which is often associated with *antimachus* by systematists, was far more common, having a slow heavy flight and being easily captured. In this case the habits serve to confirm the idea of distastefulness suggested by the appearance of the insect. But are we then to

* Bates also gives some interesting notes on the remarkable differences of habits which are to be found in this family (*op. cit.* (2), V, 1858, pp. 4, 5.

put *antimachus* in the same category, and utterly ignore that remarkable divergence in behaviour which of itself bears eloquent testimony to a profound difference between these two species in relation to their insectivorous foes?

The Pierine genus *Belenois* has also been credited with unpleasant qualities, and these are supposed to be so marked that, as recently suggested, *B. severina* has been mimicked by several species of other genera. There is nothing in the flight of this species to lend colour to such a view, and it has apparently been overlooked that in my experiments (Trans. Ent. Soc. 1902, *passim*) this insect and the closely allied *B. mesentina* were eaten by baboons with evident relish. They were also eaten without any signs of distaste by a mongoose, a kestrel and mantises; while Colonel Yerbury observed *B. mesentina* to be eaten in large numbers by spiders, and its larvæ were eagerly devoured by my baboon. The assumption of a pronounced degree of distastefulness in this case does not seem to be warranted, unless supported by experiments which shall refute the results obtained by myself.

The suggestion of inedibility in the genus *Precis* is still more instructive, and may therefore be treated more in detail.

The suggested distastefulness of the Nymphaline genus Precis.

In Trans. Ent. Soc. 1902 (pp. 424–430) Professor Poulton very strongly urged the probable unpalatability of the genus *Precis*, basing his views upon the apparent conspicuousness of the under-side colouring in the wet phases of three species. For he says: "It has here been shown that there are important [warning] elements in the under-side coloration of the wet phases of *Precis sesamus* and *P. antilope* which cannot be explained as mimicry, Batesian or Müllerian, while the entire appearance of the under surface of *P. archesia* f. *pelasgis* can only be interpreted as a warning character" (*l. c.* p. 438). This conception is further supplemented by the "inevitable conclusion" that the conspicuousness of the wet phase has been modified out of the older cryptic appearance of the dry (*l. c.* pp. 430, 431); and the tentative suggestion that the former phase may be more unpalatable than the latter (p. 441).

With regard to the black, white-spotted area at the base of the under-side of the hind-wing in the wet phase of *sesamus* and *antilope*, Professor Poulton has himself recognised that this marking is not so isolated as he at first thought (p. 427). Indeed, it actually occurs in those very Acræas to which these insects present a rough mimetic resemblance, and therefore its appearance in *Precis can.* quite consistently be explained on Batesian lines. Thus an important plank in his argument collapses.

Next as to the case of *pelasgis*, Professor Poulton says that "the conspicuous appearance of the under-sides of these forms is doubtless chiefly adapted to render them conspicuous during the attitude of rest" (p. 438). Now unlike Danaines and Acræas, I have found it no easy matter to discover a wet-phase *Precis* in an attitude of prolonged rest, and in every such case that I can recollect the butterfly had concealed itself on the under-surface of a leaf; a position which can hardly be considered to lend itself to a display of warning colours.

During my last summer in Rhodesia I kept a special look-out for *pelasgis*, and on three occasions I observed a specimen going to roost under the broad leaves of its food-plant. I trust some other entomologist will check my observations, for I must confess that I utterly failed to detect in the appearance of these insects anything which could be described, even by the widest stretch of imagination, as "startlingly conspicuous" (p. 429). On the contrary, the general effect of the colouring harmonised with the surroundings in a way one would not expect when merely examining the insect in the cabinet; for the pale transverse stripe (the so-called "warning" band) did not throw the insect into relief, but served only to break up its contour, which thus became less obvious in the lights and shadows among the leaves. I do not wish to maintain, however, that the colour of *pelasgis* is ideally procryptic; far from it. But of this I feel assured, that it would afford adequate protection to an edible species at a time when the struggle for existence is not too keen, and when the shrubs and bushes still retain sufficient leaves beneath which it may safely shelter. Nor can I think that its colouring would prove a danger to so alert and active an insect during its waking hours.

The next point to be considered is the supposition that

the brighter under-side colours of the wet phases of these species has been more recently evolved from the older cryptic pattern of the dry phase. On general grounds such a conclusion seems very difficult to accept. There can be no question that for butterflies which are on the wing throughout the year in South Africa the dry season is the time of greatest stress and danger. And from this it can only be concluded that that phase which alone is able to subsist under such conditions must present a higher degree of protective efficiency, either in colour or habits, than does the wet phase. If then it be supposed that this cryptic coloration, or some modification of it, was originally common to both seasons, it is difficult to understand why it should subsequently have been eliminated for the purpose of establishing a scheme of colouring having a lower protective value. For if this cryptic underside afforded an efficient protection from the greater risks of the dry season, it must have been amply sufficient to meet the requirements of the species during the less dangerous summer months. A comparison of various details of the patterns also seems to me to point strongly to the opposite conclusion, namely, that the dry phase is a more recent development of the wet in response to a greater need for protection; while in the case of *sesamus*, there is important experimental evidence in the same sense. In these experiments, which are as yet unpublished, I found that by the application of moisture I could convert the dry phase into the wet; but I could not convert the wet into the dry, either by dryness or cold. If we accept Weissman's arguments in respect to *Araschnia levana*, this evidence must be taken as indicating that the wet form is phylogenetically older than the dry. Thus the suggestion that the wet phase represents an unpalatable and warningly-coloured form, which has been evolved from the cryptic dry phase, finds no support. On the contrary, the evidence points to the conclusion that the cryptic dry phase is a later development in response to a greater need for protection, and also shows that there is no adequate reason why we should postulate distastefulness in the wet phase of this genus.

Finally, we may turn to the evidence yielded by the various experiments which are detailed in the earlier pages of the same paper. In the course of these experiments examples of five species of *Precis* (including

Junonia) were offered to mantises, a spider, a kestrel, a ground-hornbill, a mongoose, a monkey (*Cercopithecus pygerythrus*) and baboons; and subsequently (unpublished) to another species of monkey, *Cerc. albigularis.* In no case did the behaviour of these animals give any grounds for the supposition that the butterflies possessed any unpleasant flavour whatsoever; and the value of the evidence is obviously enhanced by the fact that the *Precis* were readily eaten by a number of very different animals. But leaving out of consideration those animals which exhibited rather indiscriminate tastes, we may briefly summarise the remaining cases:—

Precis antilope (dry phase): 2 examples eaten readily by *Cerc. pygerythrus.*

P. archesia (wet): 4 eaten with relish by kestrel; also eaten by wild rock lizards.

P. archesia (dry): 1 eaten by baboon.

P. sesamus (wet): 4 eaten with relish by kestrel; 1 eaten readily by *Cerc. pygerythrus*; 5 eaten by baboons; also eaten by wild rock lizards.

P. sesamus (dry): 2 eaten readily by baboons; 12 eaten on five different occasions by *Cerc. albigularis*, which received the first with some caution, while every subsequent insect was taken with evident appreciation, the monkey cramming them into its mouth wings and all. The same animal refused *Acræa natalica* and two species of *Amauris* with evident signs of disgust.

P. cebrene: 5 eaten with relish by kestrel; 1 eaten readily by *Cerc. pygerythrus*; 1 eaten by wild kingfisher.

The first *P. sesamus* (wet) which was given to a baboon was merely pulled to pieces without being tasted, but the remains were promptly eaten by its companion, and immediately afterwards each baboon ate another specimen. In the light of a subsequent experiment (*l. c.* p. 382), there can be little doubt that this first rejection was due to the misapprehension that the insect was an *Acræa*, to which it presents a general resemblance.

In view of all the foregoing considerations I find it impossible to entertain the idea that the genus *Precis* possesses any appreciable distasteful qualities.

The value of experiment as evidence of palatability.

The divergence of opinion which exists on the subject of palatability between the more extreme and more moderate supporters of Müller's theory practically resolves itself into a question of the relative value and reliability of the various lines of evidence available. The following are the principal sources from which information may be derived, given in the order of their importance.

(1) Exact observation as to the insects actually eaten and avoided by wild insectivorous animals.
(2) Careful experiments upon wild or captive animals.
(3) Field observations on the flight and general habits of insects in relation to their environment.
(4) The comparative study of colour patterns and structure.

The first class of evidence, which is obviously most essential, is unfortunately the most difficult to procure, more especially in the case of butterflies; for very many birds cut off the wings of these insects before eating them, and they cannot therefore be identified by an examination of the stomach contents, as in the case of insects having easily recognisable chitinous structures. Thus we must rely to a very great extent upon the three remaining sources of information.

Now in almost all those cases where the existence of unpalatability is in dispute it will be found that the arguments in its favour are based exclusively upon the fourth line of evidence. But I believe that most entomologists will agree that deductions of this kind are peculiarly liable to error unless they be supported by evidence from some other line of investigation. For my part, where I find that conclusions derived from (2) and (3) point in one direction, and those derived from (4) in another, I have little hesitation in accepting the former and rejecting the latter.

As against this, it will be contended that habits cannot be taken as an absolute proof of edibility or otherwise. For although all the butterflies that have nauseous qualities announce their presence by a characteristic demeanour, yet we must not suppose that these qualities have suddenly appeared as we now see them; on the

contrary, they will have been gradually evolved. We may therefore expect to find at the present day species in a transitional state, which, while possessing a certain degree of distastefulness, still find it necessary to retain the habits, or even the colouring, of edible forms. With this proposition I entirely agree; for it seems very probable that such cases will occasionally be found. But I fail to see that such an admission will justify a wholesale assumption of moderate distastefulness throughout all the *Pierinæ*, for example; and this is especially unwarranted in those particular cases where experimental evidence points in an opposite direction.

Here another objection is likely to be raised against me, for it will be argued that experimental evidence may at times be very misleading. Again I am quite ready to admit that there is much truth in this as a general observation. Professor Poulton insisted very strongly upon this view when commenting upon my experiments (Trans. Ent. Soc. 1902). With reference to the eating of *Acræinæ* by a ground hornbill, he says: "It has already been pointed out that the acceptance of insects by insectivorous animals in captivity is no proof of their normal likes or dislikes in a wild state. Such acceptance only proves what their action would be when they had been, from some exceptional cause, kept without their normal food in its usual quantity and variety" (*l. c.* p. 348). Unfortunately the general criticism does not happen to apply to the particular case. The bird was entirely unconfined, and wandered at will searching for his food just like his wild relatives on the next hill-side, with only this exception: if insects, etc., were scarce, the wild birds would have to go hungry or eat what they did not like, while Colonel Bowker's bird always got additional food at the house. The conditions of the experiment therefore render it highly improbable that the hornbill was eating insects which it would normally reject, and its whole demeanour was quite at variance with such a supposition.

Again, in reference to my experiments with baboons the following criticism was made: "Considering what has been already argued about insect-eating animals in confinement, the acceptances (excluding the *Hesperidæ*) probably do not justify the conclusion that the Lepidoptera were palatable, or that they would be sought for in the wild state except under the stress of hunger" (*l. c.* p. 389).

I very much regret that here likewise I am quite unable to agree to this sweeping rejection of the whole of the evidence that tells in favour of palatability, merely on an *à priori* assumption. In the carrying out of these experiments the importance of maintaining a natural diet was fully recognised, and although there will be no doubt a certain percentage of error, yet I am well satisfied that the results may be taken as giving a very fair idea as to the general likes and dislikes of these animals in regard to both butterflies and Coleoptera. Surely it must be something more than a mere coincidence that in every case where the flight or habits of a butterfly indicated the probable existence of an unpleasant taste, the baboons arrived at a similar conclusion from actual experiment. Moreover it is not quite clear why acceptance should be admitted as evidence of edibility in Coleoptera, but not in Lepidoptera.

Later on in the same paper the question of experimental evidence is summarised in the following terms: "It has already been pointed out that the refusal or evident dislike of insect food by captive animals is trustworthy evidence of unpalatability, while acceptance is not proof of palatability" (*l. c.* p. 436). This statement seems open to serious objection on two grounds. In the first place, there is too emphatic an insistence upon the possibility of error where an insect is accepted; for it practically casts suspicion upon every such case. On the other hand, the possibility of error in the other direction is not indicated. I agree that where an insect is tasted and rejected with signs of dislike, such is good evidence of distastefulness. But where an insect is merely disregarded or refused without tasting, this is not of itself reliable evidence; it may, or may not, indicate the existence of nauseous qualities. Everything depends upon the conditions of the experiment. To take a few examples. The refusal by one of my baboons of the first specimen of *Precis sesamus* (wet) cannot be interpreted as a sign of unpalatability, for this is negatived by their subsequent behaviour towards this species; the refusal was almost certainly due to either a mimetic misapprehension, or that general distrust of brightly coloured insects usually exhibited by these animals. Care also had to be exercised that too many distasteful things were not presented at once, otherwise they became very suspicious of everything offered to them.

The rejection of the first specimen of the scarlet-tipped *Teracolus achine* has likewise no significance, for on several occasions subsequently they ate fourteen similarly coloured specimens of this genus "with undoubted appreciation." Again on offering a larva of *Belenois mesentina* to the female baboon she was clearly afraid of it and tasted it most cautiously, yet on finding it all right she "eagerly devoured over twenty of them" (*l. c.* p. 385). Yet the male, which was far more timid and suspicious in temperament, "was much too frightened to eat them in spite of the example of the female." Had these larvæ been offered to the male only, it is probable that an entirely erroneous conclusion as to their extreme unpalatability would have been deduced from his behaviour. Cases of this kind might be easily multiplied, as, for instance, where unsuitable insects are offered, or where suitable insects are given to over-fed animals, and so forth.

The fact remains that even when reasonable care is exercised there must be many opportunities for error in estimating degrees of palatability or the reverse. Yet it seems a fair contention that, in the absence of obvious mistakes or inaccuracies, the true value of such experimental evidence can best be assessed by the man who actually carries out the experiments. He will be fully cognisant of all the conditions under which the experiments were made; he will presumably be acquainted with the special idiosyncrasies (often a very important point) of those animals upon which he experiments; finally, he alone is able to see and compare those subtle differences of manner, facial expression, etc., which constitute our only guide in estimating the psychological effect produced upon the animal. If similar experiments are repeated by a number of other observers the chances of error will be much diminished, and we shall thus obtain a solid foundation of fact upon which to build up those broad generalisations after which we are seeking.

A final point may be noticed. It has been suggested to me that perhaps we may be unable to demonstrate by experiment these incipient degrees of distastefulness which have been postulated for many genera of *Nymphalinæ* and *Pierinæ*. But if these unpleasant flavours are so slight that insectivorous animals in captivity are unable to appreciate them, it seems scarcely probable that they will have any real selection value, or that they will be

capable of producing the profound colour modifications which have been attributed to them. When an insect having such qualities mimics a really unpalatable species, it seems highly probable that the mimicry will have been due to the operation of Bates' factor and not that of Müller. For we must remember that birds have probably been the principal agents in producing these effects, and Professor Poulton has himself arrived at the conclusion that the discriminative tastes of birds are not as highly developed as those of mammals (Rep. Brit. Ass. 1887, p. 764). As he there says, this is what we should rather expect owing to the relative difference in their intelligence; and it is not therefore likely that a slightly unpleasant taste in a butterfly will have a mimetic importance in relation to birds, when it apparently remains undetected by so intelligent an animal as a baboon.

In conclusion, I must express the sincere regret I feel at having to insist so much upon the points in which I differ from my old friends Professor Poulton and Dr. Dixey, to whom I am so deeply indebted, not only for their continued personal kindness and encouragement, but also for the stimulating influence of their many valuable publications, with the general tenor of which I am entirely in accord. For although I have thought it necessary to point out what I consider to be definite limitations to Fritz Müller's principle, I have yet a firm belief in its reality as an objective factor which has profoundly influenced a large number of insects in the tropics. But I am likewise impressed with the equal importance of Bates' principle. I have at least the consolation of finding that my friend Mr. Roland Trimen is in close agreement with the views here advocated, and I have to offer him my grateful thanks for kindly checking the greater part of my manuscript, and for the valuable comments he has made thereon.

I can only hope that this discussion may serve to stimulate other naturalists in the tropics to undertake those experiments and observations which are so much needed for the furtherance of this fascinating line of research.

On Diaposematism, or the Interchange of Characters between Distasteful Forms. *By* F. A. Dixey, *M.A.*, *M.D.*

When in the year 1879 Fritz Müller put forward his theory of common warning colours, or the assimilation of one distasteful form to another for the sake of mutual protection against insectivorous enemies, he recognised the probability, or even certainty, that the approach would not necessarily be one-sided, but might be in the strict sense convergent, each form in some respects advancing to meet the other. This suggestion, however, so far as F. Müller was concerned, remained only in the theoretical stage; it was never developed by him, and although he mentioned a few instances in support of his view, he did not attempt to trace the supposed mutually mimetic process in any detail. There is, nevertheless, much evidence that such reciprocal approach, or interchange of obvious characters, does actually occur; and some cases of mimicry are here exhibited, the peculiar features of which are difficult to explain on any other hypothesis.

Thus the resemblance between *Leuceronia pharis*, Boisd., and the form of *Nychitona medusa*, Cram., which inhabits the same districts of Central Africa, appears to be due to mutual assimilation, the *Leuceronia* having borrowed its peculiar outline and the attenuation of the dark apical patch from the *Nychitona*, while the wings of the latter form owe their spotlessness and the comparative opacity of their white pigment, in both of which respects they differ from the forms nearest to them by affinity, to imitation of the *Leuceronia*.

Similarly, the mimetic relation between *Heliconius* as represented by *H. guaricus*, Reak., or *H. haenschi*, St. and Riff., and certain Pierines or 'white' butterflies such as *Pereute leucodrosime*, Koll., and *Pieris locusta*, Feld, may very possibly be due to an interchange of certain features between them.

Again, there is in the Island of Bali a certain Pierine butterfly, *Ixias baliensis*, Fruhst., the female of which presents a general resemblance to another Pierine, *Huphina corva*, Wallace, found in the same island. In view of the usual aspect of the nearest allies of these two forms respectively, the conclusion suggests itself that the *Ixias* has assimilated its forewing to that of the *Huphina*, and the *Huphina* its hind wing to that of the *Ixias*.

The females of certain Central and South American Papilios, or 'Swallowtails' (as *P. iphidamas*, Fabr., *P. nephalion*, Godt., &c.) are in close mimetic relation with both sexes of some common species of the Pierine genus *Euterpe* (*e.g.*, *E. approximata*, Butl., *E. tereas*, Godt., &c.) The suggestion is offered that although in most respects the Papilio has plainly influenced the Pierine, it is yet due to the influence of the latter that the females of the former have not adopted more closely the aspect of their own males.

For this phenomenon of mutual approach, or reciprocal influence, the term Diaposematism has been proposed by Professor Poulton. The possibility of its occurrence has been questioned on *a priori* grounds, but, it would appear, without sufficient reason.

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On the Palatability of some British Insects, with Notes on the Significance of Mimetic Resemblances.

By R. I. POCOCK, F.R.S., F.L.S., F.Z.S., Superintendent of the Society's Gardens and Curator of Mammals. With Notes upon the Experiments. By Prof. E. B. POULTON, F.R.S., F.Z.S.

INTRODUCTION.

At the request of Prof. E. B. Poulton, F.R.S., I undertook, in the summer of 1909 and again in that of 1910 *, to make a series of experiments in the Zoological Gardens to test the palatability of various species of British Insects. Much of the material was sent to me by Dr. G. B. Longstaff from Morthoe in Devonshire. Some I received from Prof. Poulton himself or from friends of his. A few species I added on my own account; notably the stick insects and the ants, of which we had an abundant supply in the Insect House in the Gardens. Those that I supplied I identified myself. The rest were in all cases named by the senders. To the insects Dr. Longstaff added a number of slugs, which were identified, I understand, by Mrs. Longstaff.

Since the majority of the experiments were made with English Insects, it is regrettable that English, or at all events Palæarctic birds, were, for the most part, unavailable for the tests. There were two reasons for this. In the first place, Palæarctic insectivorous birds were not strongly represented in the Society's

* Records of a few experiments made in 1911 have been incorporated in the text.

collection. In the second place, those that were in the Zoological Gardens at the time were, in most cases, kept in a very large flight aviary with plenty of cover in the way of shrubs, representing their natural environment as nearly as possible. Never having been tamed by confinement in small cages, they were too shy to come to the bars to take insects from my hand and too scared to notice them if I entered the aviary. Once or twice I tried the experiment of liberating butterflies in this aviary; but the frequency with which they escaped through the wire mesh and were wasted for the purpose in hand, induced me to abandon further experiments of that kind.

This reference to the shyness of birds in captivity brings me to another of the limitations under which I was working. I was forced to restrict my attention to particular birds, tame enough either to take insects directly from me or sufficiently accustomed to the presence of human beings in the aviary to capture liberated insects in spite of my close proximity. If I put the insects through the bars, myself standing outside, they were either seized one after another by the boldest bird in the place, or were carried by a timid bird to the back of the compartment, where I could not watch what befell them. I was compelled, therefore, to be inside the bars. Since, moreover, it was practically impossible to watch more than one bird at a time, I was precluded from the method of experimenting with the shyer specimens by giving insects to the bolder ones to distract and monopolize their attention. Thus it comes about that the same species appear over and over again in the experiments below recorded, while many insectivorous birds, that might have been tried but for their shyness, are omitted.

Two facts struck me very forcibly at an early stage of the experiments. The first was the exceeding keenness of the birds for the insects brought to them. This was no doubt due in a measure to our inability in the Gardens to feed the birds on living insects other than mealworms. The living prey was evidently a great treat to them; and over and over again I was impressed with the persistence shown by birds in persevering with insects that were obviously not to their liking, returning to the morsels repeatedly as if food of such a nature was too good to be wasted. From this I think it may be inferred that in a state of nature hungry birds will eat nauseous insects which in times of plenty they will reject after tasting, or will not take the trouble to catch them if they have previously learnt their distastefulness by experience. Furthermore, it is quite clear that the plain record of an insect being eaten is no proof of its palatability. Better evidence on this head is supplied by the behaviour of the bird towards it. After a little experience in this matter, I was able to satisfy myself at all events as to the approximate correctness of my interpretation of the bird's actions, and to judge thereby of the comparative palatability of the insects they tasted.

The second fact has an important bearing upon the criticism sometimes advanced against the theory of warning coloration and mimicry as applied to butterflies, namely, that birds under natural conditions are seldom seen to eat these insects.* Hence it has been inferred that birds cannot be reckoned as serious enemies of butterflies. Whatever may be the explanation of the circumstance, I am tolerably sure, from the behaviour of the two classes of animals when pitted against one another, that the inference drawn therefrom is erroneous. The insectivorous birds in our aviaries seemed to know at once what the butterflies were; they were on the alert the moment one was liberated and pursued it with determination and precision, following its every turn and twist, and either catching it upon the wing or pouncing upon it after settling. It is true that this predatory deftness may have been acquired in relation to the chase of insects other than Lepidoptera; but unless the birds recognised butterflies in general—a group which cannot be mistaken for other insects—as part of their natural prey, it is difficult to understand their eager excitement at the sight of those I offered them.

Again, unless the species of butterflies used for the experiments are, or were in the past, habitually preyed upon by birds, whence comes the extraordinary skill the liberated specimens, when undamaged or inexhausted by confinement, displayed in dodging the swoop of the birds in mid-air? Having repeatedly seen the aim of the pursuing bird baffled by the evasive twist of the butterfly, I cannot doubt that the insect's behaviour was prompted by the instinct to escape an habitual enemy of its species, of the same class and with the same predatory methods. It cannot, I imagine, be seriously claimed that escape from the upleap of insectivorous mammals, lizards, or frogs has been a factor of sufficient importance in survival to be reckoned with in this connection; and, *a fortiori*, the moderness of the invention of the entomologist's net puts this instrument of capture out of court for consideration. The evidence, therefore, seems to me to afford the strongest support to the conclusion that the power to dodge in mid-air and the instinct to put it in force have been fostered to subserve no other purpose than the evasion of swift-winged insectivorous foes. Perhaps predatory Pompilidæ must be regarded as a possible auxiliary influence; but apart from these hymenoptera, I can think of no enemies but birds likely to have persecuted butterflies on the wing to the extent presumably necessary to have guided their evasive tactics to the pitch of proficiency they now exhibit.

Whatever be the value of this suggested explanation of the facts, the facts themselves remain as I have stated them:—(1) Caged insectivorous birds which, so far as is known, have never been fed in captivity upon butterflies, are at once excited by

* Twice I have seen sparrows, which are not typically insectivorous, chase white butterflies in London. Two birds acting in concert were successful on the first occasion; one single-handed failed on the second occasion.

their appearance, chase them with eager speed, catch them in mid-air with precision, and eat them or taste them with avidity. (2) Pursued butterflies when overtaken often avoid the birds, not once only but twice or three times, by sudden turns up or down to right or left.

Those who hold, on the negative evidence above stated, that birds are not to be reckoned as serious enemies of butterflies, must be called upon to supply some explanation other than that above proposed of the marked reactions between these two classes of animals when brought into contact with one another, and to show reason why what takes place in the aviary may not be regarded as indicative of similar occurrences in nature.

With regard to the experiments on mimicry, especially those made with *Volucella bombylans* and *Bombus hortorum*, it appears to me that they satisfy all that the theory, as propounded by Bates, demands. They fully confirm Prof. Lloyd Morgan's experiments on birds, with the drone-fly (*Eristalis*) and the honey-bee (*Apis mellifica*), as well as those with the banded and uncoloured slips of glass holding respectively meal adulterated with quinine and meal untampered with.* They show that several species of birds, after learning by experimental tasting that *Bombus hortorum* is unpalatable, refused to touch *Volucella bombylans*.

Other items of interest that may be briefly alluded to are the experiment demonstrating, at least in the instance tried, the attractive nature of the ocelli on the wings of the peacock butterfly (*Vanessa io*); the experiments showing that *Formica rufa* is not protected from mammals and birds by its acid taste; that the black members of the Carabidæ and *Ocypus olens* are unpalatable to the ground-feeding mammals they were offered to; that *Coccinella 7-punctata* and the Telephorid beetle (? *Rhagonyche fulva*)—belonging to families of beetles which are common objects of mimicry in the tropics—are distasteful to nearly all mammals and birds.

At the end of the part of the paper describing the experiments made, I have added, at Dr. Longstaff's suggestion, for the information of those unfamiliar with the habits and distribution of the mammals, birds, and reptiles to which the insects and other invertebrates were offered, a list of the species of the former groups giving a few particulars on those points.

Finally I have to thank Prof. Poulton for kindly annotating the paper before it went to press, and for explaining more fully than I could do the bearing of some of the results on the theories of mimicry and of the connection between palatability and coloration. I am also indebted to Commander J. J. Walker, R.N., for kindly giving me the scientific names of the Lepidoptera.

* Animal Behaviour, pp. 164-165, 1900.

The Experiments

MOLLUSCA.

(Slugs.)

Large Black Slug (*Arion ater*).

Sept. 24, 1910. Two taken and eagerly eaten by two Meerkats, who wiped them down with their paws and rubbed them in the sand apparently to remove the slime.

Oct. 26, 1909. One given to Black-winged Grackle was eaten.

One (larger specimen) given to the same bird was abandoned; offered to Sulphury Tyrant, but the bird would not touch it; offered to Sun-Bittern, was pecked, but not eaten; carried to a perch by Harmonious Shrike-Thrush but was soon dropped; pecked and shaken about, and much hammered by Abbot's Rail, which managed to break the skin of the slug and getting at the inside ate a large portion, but would not eat the outside.

One taken by Dial Bird which persevered for a long time, hammering and wiping it in the sand; he was then driven off by Black-chinned Laughing Thrush, which held the slug in his foot and ate little pieces of the inside after breaking the skin, but left the bulk of it.

Dial Bird tried another, but gave it up.

Common Hangnest took one, but left it after a few pecks.

Two offered to Kagu, a kind of Crane or large Rail, were swallowed entire with very little delay.

One tried by Black-tailed Water-hen which, however, gave it up; the same specimen given to Leach's Laughing Kingfisher was ultimately swallowed entire after being dropped many times.

Arion hortensis.

(Olive-brown Slug with orange-coloured foot.)

Oct. 26, 1909. One eaten by Yellow crowned Hangnest.

Two eaten by Dial Bird.

Two refused by Harmonious Shrike-Thrush.

One twice taken from my hand by Harmonious Shrike-Thrush and dropped both times; but after taking it the third time the bird ate it.

Limax maximus.

Oct. 26, 1909. One given to Harmonious Shrike-Thrush was tried, but abandoned after one or two pecks. It was then taken and eaten by a Black-winged Grackle after a great deal of wiping of the bill.

Sept. 24, 1910. Two specimens tasted by Green Lizard, and Black-spotted Lizard, but not eaten. The Lizards apparently disliked the slime, because they wiped their mouths on the stones after tasting. Both eaten without delay by Glass Snake.

Limax agrestis.

Sept. 24, 1910. One eaten after a good deal of pecking about in the sand by White-crested Jay-Thrush.

Two eaten by a Shama.

One eaten by Kagu.

Tasted but rejected by Fantailed Flycatcher.

Tasted on two occasions by Hoopoe but rejected.

Tasted by Red-vented Bulbul but rejected.

Tasted but rejected by Yellow Hangnest.

Two taken, but not eaten, by Harmonious Shrike-Thrush.

Two taken, but not eaten, by Cuban Mocking Bird.

Limax arborum.

Sept. 24, 1910. Four eagerly eaten by Wall Lizards, which wiped their mouths to remove the slime after swallowing them.

Milax sowerbyi.

Sept. 24, 1910. One taken and pecked and wiped about in the sand for a long time by Indian Dial Bird, which finally left it.

Another specimen was eagerly taken by Sulphury Tyrant, which after pecking and crunching it in his beak, and banging it from side to side against a ledge, exactly as Laughing and other Kingfishers do, finally swallowed it whole.

ARACHNIDA.

Opiliones (Long-legged Spiders or Harvestmen).

Phalangium sp.?

Sept. 1910. One (immature) tasted but immediately rejected by Pekin Robin; the same specimen then taken and eaten by hen Scarlet Tanager.

One (immature) put into cage with several Curassows was tasted in turn by specimens of Yarrell's and the Globose, and ultimately eaten by one of the Globose Curassows, when crushed beyond all recognition.

I was led to suppose these Arachnida would prove on experiment to be unpalatable owing to their possessing a pair of glands, one on each side of the dorsal area of the carapace, which are known to secrete an odorous fluid. As elsewhere recorded *, I have seen a Mason Wasp, hunting Spiders, run down a specimen of *Phalangium*, but turn aside and let it go unhurt the moment he touched it with his antennæ. More experiments with birds and lizards are required fully to substantiate my belief; but the refusal of the Pekin Robin to eat the *Phalangium* is very significant, and it is quite evident that the Arachnid was not to the liking of the Curassows.

* Journ. Linn. Soc., Zool. xxx. p. 268, 1909.

INSECTA.

Order **LEPIDOPTERA**.

Butterflies.

Group PIERINÆ.

THE SMALL WHITE (*Pieris rapæ*).

July 31, 1909. One male (dead) given to Capuchin (*Cebus* sp. *a*) was taken at once, and eaten without being removed from the mouth for inspection. This specimen, given with *Euchloë cardamines* (see p. 820), was used as a check upon the behaviour of the monkey towards *Euchelia jacobææ* and *Melitæa artemis* (pp. 825 and 832).

Sept. 6, 1910. One offered to a Red-handed Marmoset was inspected, but not touched; but was eagerly taken and eaten by another animal of the same species. This Marmoset then ate a specimen of *Perarge megæra*, his behaviour suggesting that the two butterflies were equally palatable to him.

May 26, 1909. One chased at once by Shrike-Thrush and Dial Bird, but evaded them and escaped through the partition into next cage, where it was promptly caught on the wing by a Fantailed Flycatcher and eaten.

One caught at once on wing by Great Tit and eaten.

Aug. 21 to 27, 1910. One greedily eaten by cock Silver Pheasant.

One let loose in aviary skilfully dodged the swoop both of a Shama and a Wood-Swallow, and escaped.

One given to Dial Bird, which took it from my hands and damaged it by the peck so that it was unable to fly away. Again and again he pecked the butterfly as it fluttered about on the ground, but would not hold it. Ultimately it escaped under the partition into the next aviary, where it was pounced upon by a Weaver, which held it in his foot and ate it, leaving the wings.

Sept. 6, 1910. One taken by Masked Wood-Swallow and eaten after much delay and pecking. The bird evidently was not very keen on the insect; but he would not allow any other bird to take it from him. He did not once shake his head or wipe his beak as if there was any distasteful flavour.

One female taken and eaten by Ludwig's Bustard.

Sept. 7, 1910. One male and one female taken and eaten eagerly and with equal avidity by Green Lizard.

Larva of the Small White (*P. rapæ*), fed on cabbage.

Sept. 21, 1910. One tasted but rejected by Yarrell's Curassow and Globose Curassow.

THE GREEN-VEINED WHITE (*Pieris napi*).

July 31, 1909. One offered to White-tailed Mongoose, to three

Meerkats and to two Banded Mongooses. All rejected it after smelling it except the second Banded Mongoose, which took it with his paw, rubbed it in the sawdust, but would not eat it.

N.B.—The forceps with which this butterfly was offered had been previously used for *Ocypus olens*, *Carabus violaceus*, *Pterostichus niger* and *P. madidus*, and some *Timarchæ* as well as *Coccinella*, and probably the scent of these beetles was adhering to the steel.

May 26, 1909. One taken and eaten by Dial Bird, by Harmonious Shrike-Thrush, and by Blue Rock-Thrush.

July 26, 1909. One male given to Silver Pheasant, was taken from my fingers and swallowed instantly without being first deposited on the ground.

One female given to same bird was treated in exactly the same way.

These two I used as checks upon two specimens of *Melanargia galathea*, both of which the Pheasant treated very differently, spitting them out upon the ground after taking them from my fingers, and pecking them about a great deal before swallowing them (p. 827).

Aug. 21, 1910. One male greedily eaten by Silver Pheasant. This bird ate at the same time a specimen of *Epinephele jurtina*, showing an equal liking for both.

One male taken eagerly by Pekin Robin, which, after much pecking and tasting, left the butterfly uneaten.

July 31, 1909. One male eaten at once by Brazilian Hangnest.

Sept. 20, 1910. One left untouched by Fantailed Flycatcher. Taken and tasted but left uneaten by Dial Bird. Taken by Yellow-crowned Hangnest, which held the butterfly in his foot against the perch, pecked off its wings and finally picked it to pieces, and ate at all events most of it.

Note.—The Hangnests which ate these butterflies are much less typically insectivorous in diet than the Flycatcher, the Pekin Robin, and the Dial Bird, which refused them.

The Large White (*Pieris brassicæ*).

Oct. 26, 1909. One taken from my hand and greedily eaten by Lion Marmoset.

May 26, 1909. One taken at once by Syrian Bulbul and eaten; also by Harmonious Shrike-Thrush.

Oct. 26, 1909. One taken from my hand and greedily eaten by cock Silver Pheasant and by Honduras Turkey.

One taken by Shama and finally eaten, but not with any approach to the readiness with which he had just previously eaten a Tortoise-shell and the *E. jurtina*. At one time I thought he was going to give it up; but finally he swallowed it.

One liberated in aviary was chased up and down by three Wood-Swallows which, however, owing to hesitancy at the moment

of coming to close quarters, did not catch it. It escaped into another compartment, and was promptly seized by the Harmonious Shrike-Thrush, which ate it after a deal of pulling about and tasting.

Aug. 21, 1910. Two males greedily eaten by cock Silver Pheasant.

One male caught by Pekin Robin and eaten after some time, the delay being caused not apparently by distastefulness, but by the difficulty of getting rid of the wings which were left uneaten. This bird held the insect to the perch with his foot when pecking.

One male eagerly taken by Pearl-spotted Owl, which held it up in one foot while pecking it. He pecked away for some time at the thorax and wings without making much headway. He then shifted it and pecked off the end of the abdomen. But as soon as he got the flavour of the exposed tissues he shook his head and repeated the shake with every taste, showing unmistakable signs of disliking the flavour. Finally he hopped to another perch, put the butterfly down, and after looking at it for a little time, flew away. I thought he had given it up; but upon returning to the cage ten minutes later the butterfly had disappeared.

One put into an aviary of Tanagers was chased by several birds which, however, hesitated at the critical moment to catch it, as if a little doubtful as to its nature. At last a male Scarlet Tanager took it in his beak, but not having the instinct to use his foot to hold it or to put it into a cranny, went on masticating it for at least five minutes without showing any signs of dislike. He apparently refrained from swallowing it on account of the wings. Ultimately he was robbed by a female of the same species, which, after getting rid of the wings, continued pecking and tasting and shaking her head in the intervals, quite obviously not enjoying the flavour. She managed the insect better than the male, jamming it first into a split orange, and then between the leaves of a palm to peck it the better. Ultimately she ate what was left of the body.

One male offered to a hen King Bird of Paradise. She looked at it and as soon as she saw the legs move took it, but dropped it at once to the bottom of the cage. After careful and long inspection, she pecked it once or twice, but showed no eagerness to eat it. I then gave the same insect to a Larger Hill Mynah, which soon swallowed it, wings and all.

One male taken and eaten at once by Ludwig's Bustard.

One male offered to Fantailed Flycatcher, but he would not touch it. Taken and tasted by Dial Bird, but left uneaten. Also taken and tasted by Black-winged Grackle, and left and subsequently refused twice. Quickly eaten up by Harmonious Shrike-Thrush.

Sept. 18 to 20, 1910. One caught on wing by Fantailed Flycatcher, which had just eaten a 'Blue.' He carried it to a window-sill, but after one or two pecks left it. Once or twice the

bird, after waiting a short while, tried it again, but finally left it alone.

It was then taken by a Dial Bird, which, after pecking it about for a short time, was robbed by the Sulphury Tyrant. The latter, after tasting it, left it alone. I then gave the remainder of the insect, consisting only of the thorax and wings, to a Yellow-crowned Hangnest, which took it to a perch, and holding it in one foot gradually pecked away the wings and dropped them, and then pecked the thorax to pieces, eating little bits of it and dropping others.

Pupa of the LARGE WHITE (*Pieris brassicæ*).

Oct. 26, 1909. One offered to the Dial Bird which had fifteen minutes previously eaten the larva, but he would not touch it.

Offered to Yellow-crowned Hangnest which had tasted and dropped the larva. He looked at it but would not touch it.

Given to Harmonious Shrike-Thrush, which behaved just as the Dial Bird had behaved with the larva, pecking it and dropping it repeatedly to shake his head. He was then robbed of it by a Common Mocking Bird, which, however, dropped it in the grass from the perch, and made no attempt to recover it.

One offered to a Black-winged Grackle, a Javan Pied Mynah, a Fantailed Flycatcher, and a Sulphury Tyrant, all of which tasted it once, but not a second time. A Common Mocking Bird persevered a little longer, but finally dropped it and made no effort to pick it up again. Given to Harmonious Shrike-Thrush, was eaten without much hesitation.

Larva of the LARGE WHITE (*Pieris brassicæ*).
Food not recorded.

Oct. 26, 1909. One taken by Yellow-crowned Hangnest, but soon dropped. Pounced upon by Dial Bird, which after many trials, pecking it and shaking his head after every taste, at last swallowed it; but he was evidently very uneasy for some twenty minutes afterwards, periodically shaking his head and opening his mouth and straining as if trying to vomit something nauseous.

Larvæ of the same fed on *Tropæolum* (so-called Nasturtium).

Sept. 13, 1910. Three eaten readily by Silver Pheasant and Reeves's Pheasant.

A small one given to Pekin Robin, which obviously did not like the flavour. He pecked it about in the sand for a long time, vigorously shaking his head after each taste. Ultimately, however, he ate it. I then gave him as a test the larva of a *Noctua* (see p. 835), which he also took and very soon swallowed entire without once shaking his head or evincing any sign of dislike. He then took a second and larger *brassicæ*-larva, treating it just as he did the first, but tackled it with still greater reluctance,

allowing himself to be robbed of half of it by another bird of the same species. The two finally finished it between them.

One given to a Shama, which after pecking and tasting it for a long time, with much headshaking, left it. It was then tasted by a Wood-Swallow, which left it after one peck. The Shama then tried it again, but left it. Then a Red-vented Bulbul took it, but soon dropped it. The Shama then tried it again and ended by eating it. This Shama was the same bird that ate the *Coccinella 7-punctata* (p. 846).

One given to Kagu, which after several attempts left it; and immediately afterwards greedily ate the larva of a *Noctua* (p. 835). This same Kagu ate *Timarcha tenebricosa.*

One taken by Green Hangnest, which at the time was greedily eating mealworms. The bird finally ate it, but evidently did not much like it, putting it down several times, and wiping it in the sand.

One given to Pearl-spotted Owl, which dropped it at once.

One given to Butcher Crow, which dropped it directly; but afterwards picked it up and swallowed it whole. Immediately afterwards, however, he vomited it up and left it on the bottom of the cage.

One smelt, but not touched by Common Marmoset, and by Capuchin.

One eagerly eaten by Meerkat.

Sept. 21, 1910. Larvæ of the same, fed on cabbage (*Brassicæ*).

Taken and eaten by :—

Elliot's Pheasant, Reeves's Pheasant, and Silver Pheasant. Vulturine Guinea Fowl. Crested Guinea Fowl. Ludwig's Bustard. Vigors's Bustard. S. American Thicknee. Cariama. Crested Curassow. Nigerian Ground Hornbill.

Also by Meerkats and Banded Mongoose.

Tasted but rejected by:—Shama, Red-vented Bulbul, Green Hangnest, Black Hornbill, Elate Hornbill, Trumpeter, Yarrell's Curassow, Globose Curassow, Crested Curassow, and Red-tailed Guan.

Notes.—The nature of the food of the larvæ did not appear to affect their taste. The Green Hangnest, it is true, refused larvæ fed on cabbage, having a week earlier eaten one fed on *Tropæolum*, but the bird was not eager for the latter, and I do not think this refusal of the former can be taken as strong evidence that he found them more unpalatable than the others. It is interesting that the Pheasants and Guinea Fowl, that is to say, Asiatic and African Gallinaceous birds, ate the larvæ eagerly, while the S. American Curassows and Guans, with the exception of one Crested Curassow, refused them after many trials, and much head-shaking. One Curassow eagerly ate the larva of the *Noctua* (p. 835) after refusing that of *P. brassicæ.*

The Orange-tip (*Euchloë cardamines*).

July 31, 1909. One male given to *Cebus* (sp. *a*) was seized at once and stuffed into his mouth. He took it out, looked at it, smelt it, then ate it without hesitation.

This was a check experiment upon the behaviour of the monkey towards *Euchelia jacobææ* and *Melitæa artemis*. He showed much greater alacrity in eating the *cardamines* than either of the others. A *Pieris rapæ* given at the same time he ate without removing it from his mouth.

May 26, 1909. One male taken by the Harmonious Shrike-Thrush after a few moments' inspection and eaten entire, wings and all, with much less delay in the way of pecking and scraping on the soil than the same bird displayed when dealing with *M. artemis* and *A. euphrosyne*. Tested by this bird, *E. cardamines* appeared to be more palatable: but it is possible, though I do not think probable, that he ate it with less delay because he had just previously been robbed of the specimen of *Argynnis euphrosyne* by not swallowing it at once.

Group Nymphalinæ.

The Small Tortoise-shell (*Vanessa urticæ*).

Oct. 26, 1909. One taken and eaten by Shama which had just previously eaten *Epinephele jurtina*.

Hoopoe, Black-winged Grackle, and Harmonious Shrike-Thrush very eager to take one, but it was secured by the Grackle, which, however, was robbed by the Shrike-Thrush, the latter eating the butterfly in about half a minute without any signs of dislike such as shaking his head or wiping his beak.

Sept. 7, 1910. One taken and greedily swallowed, wings and all, by Dial Bird.

Sept. 18, 1910. One caught on wing by Fantailed Flycatcher, who carried it to a perch, but after a few tastes and pecks dropped it to the ground. Whether this was done intentionally or accidentally I cannot say, but the bird made no attempt to follow up the insect. I then gave it to a Dial Bird, which, after pecking it for a short time, was driven off by a Sulphury Tyrant. This bird, however, did not touch the butterfly. I then offered it to a Bulbul and a Yellow-crowned Hangnest; but neither touched it. I then offered it again to the Dial Bird, who finished it, but with no show of appetite. I am unable to say whether the indifference shown by the birds to this butterfly was due to its being distasteful or to the experiment being made at 5 P.M., when the birds had been feeding off and on through the day.

Pupa of *Vanessa urticæ*.

June 24, 1909. One placed on a branch near a Shama was taken after a good deal of preliminary inspection but was soon

flicked away and fell to the ground. The bird made no attempt to recover it. I then again put it on the branch by his side, and on this occasion he pecked at the little stem to which the pupa was attached. A hen Black Tanager was the next to try it. She broke the shell and getting the taste flew away with the pupa and, I think, ate it. At all events she flew up to the top of some brickwork where I could not see her clearly, and presently came down again without the pupa; and on going up a ladder to look for the pupa, I could find no trace of it.

One offered to Syrian Bulbul was taken after some scrutiny. The bird flew away with it and pecked it, but seemed greatly bothered and puzzled by the tightness with which it adhered to the twig. He was unable to detach it from the twig, and finally left it. I then offered it to a Fantailed Flycatcher; but could not induce this bird to touch it, although he scrutinised it carefully and was hovering round me the while, apparently remembering that on previous occasions I had given him butterflies. I then gave it to the Harmonious Shrike-Thrush, which took it, pecked away at it until he broke off the tail-end and ate it. He then pecked off another piece and ate it, showing no sign of dislike. He then left the larger piece; but soon returned, broke it up, and finally ate it piecemeal.

From watching the behaviour of these birds, I should say that these pupæ are unpalatable only to the extent afforded by the hardness and toughness of the chitinous integument. The birds that tasted them after breaking the exoskeleton, showed no signs of disliking the flavour. Those that took them—and the Flycatcher could not be induced even to attempt it—did so after scrutinising them in a way that suggested doubt as to their belonging to the category of eatable things. They did not appear to me to know what they were; and none of the many insectivorous birds in the aviary showed the least sign of eagerness when I first put the pupa on a perch, waiting to see which would be the first to come down. It was only when I placed it about a couple of inches from the Shama, a tame and fearless bird, that he took it. The Tanager came, and after her the Bulbul, when they had seen the Shama's attempt, or at all events after the Shama had first tackled it. These birds are accustomed to visitors and keepers bringing food into the aviary; and I think it probable that the Shama was induced to peck at the pupa merely because it was definitely offered to him.

I suspect that this pupa is protected in the first place by its likeness to things inanimate, and in the second place by the toughness of its integument which does not readily yield to a peck, and is quite in keeping with the general impression of lifelessness suggested by the colour, shape, and immobility of the whole pupa. I may add that I did not see the pupæ move when pecked by birds, although they did so when handled by myself.

Young larvæ of *Vanessa urticæ.*

June 24, 1909. One eaten without hesitation by Brazilian Hangnest, and by Common Mocking Bird; two by Shama; two by Orange-headed Ground-Thrush, and one by Harmonious Shrike-Thrush.

Two taken and tasted but whisked away by Larger Hill Mynah.

One taken and tasted but dropped by North American Cat-bird, which refused to touch a second.

One pecked and tasted many times, but finally rejected, by Fantailed Flycatcher.

THE PEACOCK (*Vanessa io*).

May 26, 1909. One fluttered to ground and rested with wings closed. A Fantailed Flycatcher flew down to inspect and was preparing to peck, when the butterfly opened its wings and moved them slowly up and down. The transformation seemed to disconcert the bird, which made no attempt to peck, but danced round the insect at a distance of about three inches. A Shama and another Flycatcher, which joined the first, behaved in the same way. A Syrian Bulbul then flew down and drove the three away. After inspecting the butterfly for about half a minute, he pecked the ocellus of the anterior wing of the left side; the second peck struck the ocellus of the anterior wing of the right side; the third the ocellus of the posterior wing of the left side, tearing a piece out. He was then driven away by a Sun-Bittern, which looked at the butterfly for some two minutes, but made no attempt to peck it, although it excited his interest. I then removed the Bittern; and the Bulbul returned at once, seized the butterfly by the head and thorax, flew away with it, and devoured it.

One fell to floor of aviary with wings closed, and was at once seized by Syrian Bulbul, before its wings opened, and was carried away and eaten. A second Bulbul of this species pursued the first; but I do not know which of these two birds was the one that ate the *io* first introduced.

The two features of interest in the first experiment with this species were, first, the manifest disconcertedness of the three birds by the sudden display of colour and the slowly waving wings of *io* (my wife, who was with me, said at once, "They are afraid of its eyes"); and secondly, the consecutive pecking of three of the ocelli by the Bulbul. It can hardly have been by accident that the ocelli were accurately struck three times running.

Aug. 21, 1910. A specimen let loose in aviary was chased by a number of Tanagers and other small birds and was caught by a Scarlet Tanager. The latter, however, was robbed by a Pekin Robin, which ate the insect without showing any signs of dislike, the delay of five minutes in finishing it off being caused by the difficulty of managing the wings, which the bird ultimately broke off and left uneaten.

THE RED ADMIRAL (*Pyrameis atalanta*).

Aug. 21, 1910. One taken and eaten greedily by Lion Marmoset.

One pursued by Shama, which grabbed it by the hind wing and thereby lost the butterfly, which flew away and escaped through the wires of the aviary.

THE PAINTED LADY (*Pyrameis cardui*).

Aug. 27, 1910. One given to Pearl-spotted Owl was taken at once and swallowed entire after a little preliminary pecking.

This was a test experiment to ascertain the meaning of the bird's behaviour towards *Pieris brassicæ* (see p. 817).

Araschnia levana. Late summer form *prorsa.*

July 8, 1911. One given to Harmonious Shrike-Thrush, an Australian bird, was taken at once, but after being pecked and tasted for some little time, was rejected. The remains were then greedily eaten by a Wood-Thrush, from North America. A fresh specimen given to this same Wood-Thrush was just as readily swallowed; but the Shrike-Thrush upon taking another, treated it as before, wiped it in the sand, shook his head, and allowed himself to be robbed by a Black-chinned Laughing Thrush, which ate it and another without hesitation.

One taken and eaten, but very slowly and with much pecking about, by a Hoopoe, which, after swallowing the last particle, appeared to try to vomit it back but without success.

A Blue Rock-Thrush and a Common Rock-Thrush, both European birds, each ate one greedily.

One pecked and tasted for some little time by Orange-headed Ground-Thrush, which obviously did not care for the flavour, and allowed himself to be robbed by the Blue Rock-Thrush mentioned above.

One liberated in aviary dodged the pursuit of a Shama and a Sibia with great skill, and escaped.

One given to Shama was pecked and tasted for some time, but the bird allowed himself to be robbed by a Wood-Swallow, which, after much pecking, swallowed the butterfly.

This performance was repeated exactly when one was given to the Sibia, the same Wood-Swallow taking it from him; but I think the Sibia would have eaten it ultimately.

One given to Grey-headed Friar Bird, from Australia, was taken and tasted for a long time and then dropped, given again to the same bird, was again tasted and dropped. The remains were then eaten without much delay by a Larger Hill Mynah.

One given to a Dial Bird was taken and after much tasting was resolutely rejected. The remains were then given to a

Sun-Bittern, which persevered for some time but finally rejected them.

The only birds which ate the butterflies quite readily were the two species of Rock-Thrushes, the Wood-Thrush, and the Black-chinned Laughing Thrush. To the others they were obviously more or less distasteful, the most significant rejection being by the Shrike-Thrush, which on previous occasions has eaten almost every insect offered to him.

N.B.—These experiments were made between 4 and 5 P.M., when the birds had been feeding throughout the day.

July 9, 1911. One eaten readily by Black-headed Lemur, one by Meerkat, two by Common Indian Mongoose.

Three eaten readily by two Wall Lizards.

Two eaten readily by Silver Pheasant, and one fairly readily by Mantchurian Crossoptilon (Pheasant).

One given to White-eared Scops Owl was taken at once but dropped as soon as tasted.

Experiment repeated with same result.

Experiment repeated with same result with another specimen of the same species of Owl.

One given to Pekin Robin was taken at once, but put down upon the ground. For fully five minutes the bird continued to peck it and shake his head. He would neither eat it himself nor allow the other birds to take it from him. Ultimately he pecked it to pieces; but I cannot say whether he ate particles or wasted them on the ground. One thing was quite clear. He did not find the flavour to his liking.

Dark Green Fritillary (*Argynnis aglaia*).

July 21, 1909. One let loose in aviary was chased by Black-headed Sibia and Fantailed Flycatcher, but eluded both and escaped into a crevice. This is the first butterfly I have seen dodge the Flycatcher, which is extraordinarily adept at taking insects on the wing. I then gave it to the Spectacled Thrush, and he ate it after he had succeeded in shaking off its wings. The bird was keen not to lose it, and drove away the Flycatcher whenever he ventured near.

Silver-washed Fritillary (*Argynnis* (*Dryas*) *paphia*).

July 26, 1909. One caught on wing and eaten with avidity by Fantailed Flycatcher.

Also used as check upon *Melanargia galathea* which the Flycatcher had rejected (see p. 827).

July 31, 1909. One eaten readily by Brazilian Hangnest.

Pearl-bordered Fritillary (*Argynnis* (*Brenthis*) *euphrosyne*).

May 26 to 31, 1909. One eaten by Silver Pheasant. For details see under *Melitæa artemis* (see p. 826).

Two specimens given respectively to Brazilian Hangnest, and to Saturnine Mocking Bird, were eaten much more readily than were specimens of *M. artemis* offered to the same birds (see under *Melitæa artemis*).

One female taken by Harmonious Shrike-Thrush, but not eaten readily. While this bird was pecking the butterfly and wiping it on the gravel, he was robbed of it by a Red-vented Bulbul; the latter was in turn robbed of half of it by a North American Mocking Bird. The two finished it between them.

Small pearl-bordered Fritillary (*Argynnis* (*Brenthis*) *selene*).

May 31, 1909. One taken and eaten by Capuchin, but without relish.

One taken and eaten by Capuchin (*Cebus* sp. *c*), with obvious avidity.

Greasy Fritillary (*Melitæa aurinia* or *artemis*).

May 26 to 31, 1909. One male given to same specimen of *Cebus* that took the *Euchelia jacobææ* five minutes previously. He behaved in exactly the same way towards it. Stuffed it into his mouth, but the moment he got the flavour or the feel, took it out in his hands, pulled it to pieces, cautiously tasted it, and then ate it, but with no great show of satisfaction.

One taken and eaten by Capuchin (*Cebus* sp. *b*), but with great hesitation and no particular signs of relish. This monkey also ate one *Cœnonympha pamphilus*, one *Argynnis selene*, and one *Thanaos tages*; but treated them all in the same way, evidently not caring much for any of them. In this particular he showed a marked contrast to the two other examples of *Cebus*, sp. *a* and *c*, used for these experiments.

One male offered to Meerkat, taken and eaten at once. Eager for more.

One male offered to Capuchin, taken and eaten at once. Eager for more.

One male offered to White-handed Lemur, which after carefully smelling it, refused it.

Same one offered to Crowned Lemur and White-fronted Lemur, was smelt and refused in the same way.

Offered to Black Lemur, was smelt, then carefully taken into the mouth, but was then pulled out with the hand; then again tasted, but rejected as if distasteful, the tongue being rapidly protruded and drawn back through the front teeth as if to scrape off something unpleasant, perhaps scales.

One offered to Diana Monkey, was taken and eaten piecemeal, apparently with relish.

The mammals above mentioned had not been fed, and were without exception hungry.

One taken by Brazilian Hangnest, which pecked at it, ate a few pieces as if testing its flavour, then let it fall from the perch to the ground, and left it there.

One taken by Saturnine Mocking Bird, which shook it about, pecked it, ate a fragment or two, then left it.

One taken by Brazilian Hangnest, which pecked it several times, and finally ate it. The Mocking Bird then returned, and after many trials finished off the remains of the first specimen that had been left by the Hangnest and of the second that had been left by himself. It was quite evident that neither of these birds found much satisfaction in eating these butterflies.

One female liberated in aviary, caught on wing by Garrulous Honey-eater, and eaten without delay.

One female taken by Blue Rock-Thrush, but left on the ground after being pecked. Suspecting that his leaving it was due to my propinquity, I moved away and told the keeper to throw it to him, He then caught it on the wing, and ate it. He then came close to me on a perch and eagerly took another specimen (male) from my hand, then a third (female), and ate both greedily.

Two given to Silver Pheasant were taken and eaten, but with a great deal of pecking and tasting. Comparing this bird's behaviour towards them with his manner of eating *Pieris napi* and *rapæ*, I am quite sure he found them to a certain extent unpalatable. I thought at first that he merely disliked the wings. To test this I gave him immediately afterwards a specimen of *napi*. He took it from my hand and put it on the ground; then tasted it, and without more ado swallowed it. I then gave him a specimen of *rapæ*. He took it from me, and without putting it on the ground ate it up. I then gave him a specimen of *Pararge megæra*, which flew into a bush. He went after it, found it, caught it with the dexterity of a 'practised hand,' but treated it exactly as he treated the *artemis*, pecking and whisking it about, ultimately after much delay eating it piecemeal, but with what might be described as a very dubious air. He behaved in a precisely similar manner towards an example of *Argynnis euphrosyne*.

I am convinced that no one who had seen this Pheasant eat these five butterflies, could have doubted for a single moment that he found the 'Whites' pleasant to taste, and the 'Fritillaries' not altogether to his liking.

One male offered to Larger Hill Mynah was taken and eaten, but with no great relish, being frequently dropped and picked up again, and scraped in the sand.

One male offered to Levaillant's Barbet, which took it and behaved towards it in exactly the same way as the Mynah. The birds appeared to dislike the wings, and to want to get rid of them.

One male offered to Fantailed Flycatcher, which after a little inspection pecked it and took it, but was robbed by a Syrian Bulbul, which ate it.

Two males taken and eaten by Shama.

One male taken and eaten by Cape Robin-Chat.

One male taken and eaten by Indian Orange-headed Ground-Thrush, after being pecked and rejected by Hoopoe.

One male taken and eaten by Harmonious Shrike-Thrush.

One female taken and eaten after a great deal of pecking and delay by Indian Black-headed Sibia, which was chased for it by a Syrian Bulbul.

One female taken and eaten, after a few moments' inspection and biting at the wings before the position of the body was found, by a Sand Lizard. A Dugès's Lizard came up while the butterfly was being chewed, and after tasting it once or twice, attacked the Sand Lizard to make him relinquish his hold.

One male taken by the same Sand Lizard after he had finished the first specimen. I then made him drop it; and offered it to a Wall Lizard, which took it without delay and swallowed it.

Group SATYRINÆ.

THE MARBLED WHITE (*Melanargia galathea*).

July 24, 1909. As a check I first of all offered a specimen of *P. napi* to the cock Silver Pheasant. He took it from my fingers, and without hesitation swallowed it and turned eagerly for more. I then gave him a *galathea*, which he just as eagerly took, but promptly lowered his head to the ground and spat it out. He persevered with it, however, and after a little pecking and shaking, ate it. I then tried him with another *napi*. He took it and swallowed it at once, not hesitating for a single moment, exactly as he had done with the first one. Then I gave him another *galathea*, which he took but immediately put out of his beak upon the ground; but after some pecking and tasting he swallowed it.

I consider this bird to have rather a refined taste for insects; and I can now tell tolerably accurately by his behaviour whether he likes one or not. And I am quite sure that he found *napi* very palatable and *galathea* not so.

I then let a *galathea* loose in the aviary, and it was promptly caught on the wing by a Fantailed Flycatcher, which flew with it to the ground, and after pecking, pulling and shaking it about for a minute or so, gave it up and took no further notice of it. As a check I then tried him with *Aphantopus hyperanthus*, which he caught in the same way, and very quickly demolished. I then gave him another *galathea*, which he caught and pecked and shook for some little time; but he would not eat it. As a further check I gave him *Argynnis paphia*, which he caught and disposed of as quickly as he had disposed of the *hyperanthus*.

I noticed that some of these *galathea* had darker spots below than the others. Thinking that perhaps this might be a sexual difference, I gave one of each kind to the Pheasant and to the Flycatcher; but the birds behaved in exactly the same way towards them.

One caught and eaten by Dial Bird; also by Orange-headed

Ground-Thrush, and by White-cheeked Bulbul. The latter was robbed by the Harmonious Shrike-Thrush; but recovered the butterfly and ate it.

One given to Sulphury Tyrant, who pecked it and shook it for a long time, then allowed the Shama to take it from him. The Shama ate it. This was a *galathea* with lighter spots below.

One given to the same Shama was also eaten. This was a darker spotted specimen.

The specimen above alluded to that was rejected by the Flycatcher, was eaten by a North American Cat-bird (Thrush).

One offered to Australian Bustard, was taken from my hand and swallowed at once.

One given to Meerkat, was taken and eaten without hesitation.

One given to Capuchin, which by his rejection of the Telephorid beetle (p. 840) had shown himself to be more particular in taste than some others of his species, was eaten, but by no means greedily.

With the exception of the Australian Bustard none of the birds that ate the *galathea* did so with great alacrity. Swallowing them was in all cases preceded by a varying amount of flicking and shaking and pecking. When I began my experiments I thought this behaviour was due to a wish to get rid of the wings; but I am now doubtful about this, and believe that in many cases at all events it indicates dislike of the taste. When a butterfly is really to the liking of a bird, he disposes of the insect as fast as he can, without paying much attention to the wings. This struck me to-day particularly in the case of the Silver Pheasant when eating the *napi*, and of the Flycatcher when eating the *hyperanthus* and the *paphia*. The *paphia* especially was a large-winged butterfly for so small a bird; and yet he swallowed it, wings and all, in a few seconds.

THE MEADOW BROWN (*Epinephele jurtina* × *janira*).

July 21, 1909. One female eaten at once by Lion Marmoset, which had previously refused to taste the malacoderm beetle (*Rhagonyche*) and the Saw-fly (*Allantus arenatus*).

One female taken from my hand by Spectacled Thrush, but made his escape. Caught on wing by Fantailed Flycatcher and eaten at once.

One female eaten at once by Common Pheasant.

July 31, 1909. One male caught on wing by Black-headed Sibia and eaten at once; another (female) caught on wing and eaten without delay by Fantailed Flycatcher.

Aug. 21, 1910. One male greedily eaten by Silver Pheasant. This bird at the same time ate with equal avidity a male specimen of *Pieris napi*. Her behaviour indicated no difference of taste between the two butterflies.

Oct. 26, 1909. One female taken and eaten fairly readily by Shama.

THE LARGE HEATH OR GATEKEEPER (*Epinephele tithonus*).

July 31, 1909. One eaten at once by Brazilian Hangnest.

Aug. 25, 1910. One caught and quickly swallowed entire by Pekin Robin.

One male taken and swallowed entire with scarcely any delay by Pearl-spotted Owl.

Sept. 20, 1910. One caught on wing and eaten without delay by Fantailed Flycatcher. This bird would not touch two White Butterflies (*P. brassicæ* and *napi*), offered one just before and one just after it took *tithonus*.

THE RINGLET (*Aphantopus hyperanthus*).

July 26, 1909. One caught on wing and eaten with all speed by Fantailed Flycatcher.

I used this specimen as a check upon *galathea*, which the bird had just refused to eat after catching it and pecking it about for some time.

One gobbled up at once by Silver Pheasant.

THE SMALL HEATH (*Cœnonympha pamphilus*).

May 26, 1909. Two taken and eaten at once by Fantailed Flycatcher.

One taken by Fantailed Flycatcher which was at once chased by Syrian Bulbul.

One seized by Orange-headed Thrush, which after carrying it about gave it through the bars of the partition to another bird of the same species. This was deprived of it by a Bower Bird, which carried it about, perhaps as a possible ornament, since he made no attempt to eat it.

THE WALL BUTTERFLY (*Pararge megæra*).

May 31, 1909. One taken and eaten by Capuchin (*Cebus* sp. *b*), but without apparent liking (see under *Melitæa artemis*).

One taken and eaten with avidity by Capuchin (*Cebus* sp. *c*).

Aug. 25, 1910. Eagerly taken and eaten by Red-handed Marmoset.

May 31, 1909. One eaten by Silver Pheasant (see also under *Melitæa artemis*).

Aug. 25, 1910. Two (male and female) caught and greedily eaten, wings and all, by Pekin Robin.

Sept. 5 to 7, 1910. One female taken at once by Ludwig's Bustard, which, however, let it escape. It was caught on the wing and quickly eaten by a Larger Hill Mynah. Two more specimens (female) eaten by Black-winged Grackle and by Dial Bird.

The Grayling (*Satyrus semele*).

July 31, 1909. One caught on wing by Fantailed Flycatcher and eaten with all speed.

Group Lycænidæ.

Common Blue (*Lycæna icarus*).

Oct. 26, 1909. One given to Shama, but it avoided him and flew through into the next compartment, where it was captured smartly by a White-browed Wood-Swallow, and eaten as soon as the bird could get peace from the pursuit of two other Wood-Swallows in the same compartment.

N.B.—These Wood-Swallows were desperately keen to get the butterflies with which they saw me feeding the Shama in the next compartment.

One male let loose in aviary containing Fantailed Flycatcher, which I should describe as an expert butterfly-catcher. But the Blue dodged him again and again, and got through into the next compartment. Here again it avoided the swoop of one or two birds whose identity I did not detect in my intentness in keeping my eye on the butterfly. The latter then passed through to a third compartment and settled on some yellow painted boarding, which it did not match, and on which it was caught by a Brazilian Hangnest, and quickly eaten.

One male caught deftly by Masked Wood-Swallow, which after prolonged pecking and tasting, swallowed the body, having got rid of the wings. This bird used its foot to hold the insect down.

One male caught by Pekin Robin and ultimately swallowed entire; but the bird put the insect down many times before swallowing it.

The behaviour of these two birds suggested that this 'Blue' was not very palatable. Its size offered no obstacle to its being swallowed at once; but both birds delayed over the meal.

Two (male and female) given in succession to Pearl-spotted Owl were taken and swallowed entire without delay.

Two (male and female) let loose in aviary were captured and quickly swallowed entire by Pekin Robin.

The Brown Argus (*Lycæna astrarche*).

Sept. 18, 1910. One let loose in aviary was taken by a Cayenne Tanager, which was quickly robbed by a Pekin Robin. The latter ultimately swallowed it entire, after putting it down several times before finishing it off.

One caught on wing and eaten at once by Fantailed Flycatcher.

One caught and eaten at once by Dial Bird.

The Small Copper (*Chrysophanus phlœas*).

Aug. 25, 1910. One caught and swallowed quickly, wings and all, by Pekin Robin.

Group Nemeobiinæ.

The Duke of Burgundy (*Nemeobius lucina*).

June 15, 1909. One given to Brazilian Hangnest was taken and swallowed without any hesitation.

One given to Saturnine Mocking Bird was taken at once, but not eaten eagerly. While she was pecking it about a Lesser Hill Mynah flew up and took it away, but was in turn deprived of it by the Mocking Bird, which then swallowed it quickly.

Two given to Silver Pheasant, which ate them with the same eagerness as it had previously shown when tried with the 'Whites.'

Group Hesperiidæ.

The Dingy Skipper (*Thanaos tages*).

May 31, 1909. One taken and greedily eaten by Dent's Monkey.

One taken and eaten cautiously by Capuchin (*Cebus* sp. *b*). See under *M. artemis.*

The Large Skipper (*Argiades sylvanus*).

July 21 to 31, 1909. One caught and eaten at once by Fantailed Flycatcher, and one by Brazilian Hangnest.

Moths.

Larva of Goat-Moth (*Cossus ligniperda*).

Sept. 20, 1909. One taken first of all by Dial Bird, which after a short time was driven off by Sulphury Tyrant. Both, after pecking it, left it practically uninjured on the ground. It was then taken by the Harmonious Shrike-Thrush. He kept it for some time, pecking it about and was eager to prevent other birds getting it; but was finally beaten in a 'tug-of-war' for it by a Common Hangnest, which carried the grub to a bush, held it against a branch with his foot, and pecked away for five minutes, then voluntarily dropped it. It was then taken by a Dial Bird, which persevered for a long time, pausing frequently between the pecks, opening and shutting and wiping his beak. He was then deprived of it by a Black-chinned Laughing Thrush, which kept it for ten minutes, pecking and whisking it about without making any visible impression on the skin. The head, however, was by this time gone, and the bird pulled some soft tissues out of the end and ate them. I then gave it to a Green Hangnest, but after tasting it he let it drop and took no further notice of it. I then gave it to a Leach's Laughing Kingfisher, which after a little delay swallowed it whole.

Larva of the LACKEY (*Clisiocampa neustria*).

Sept. 20, 1909. Seized at once by a Shama which flew away with it, holding it by the head; but while he was adjusting it for eating, the female Black Tanager grabbed the other end and being victorious in the tug that ensued, carried away the larva and, after a good deal of pecking, ate it.

SIX-SPOTTED BURNET (*Anthrocera* (*Zygæna*) *filipendulæ*).

July 31, 1909. One placed on a branch was immediately seized, but flicked away by a Black-headed Sibia, which made no attempt to follow it up but flew away, shook his head once or twice, and wiped his beak.

Sulphury Tyrant then pecked it and flicked it away; and tried it again with the same result, and left it.

Harmonious Shrike-Thrush took it eagerly, wiped it on the ground several times, then jammed it into a forked branch and started gingerly pulling it to pieces with much shaking of his head and wiping of his beak. He then broke it in two pieces; flew away with one and pushed it into a cranny and still persevered. He then broke another piece off, and stuck it in a cleft branch; but finally left it. I did not see him eat any of the moth although he may have swallowed small particles. In any case there were pieces of it left in the places where he had fixed them.

THE CINNABAR MOTH (*Euchelia jacobææ*).

July 31, 1909. One given to Meerkat, which caught it on the wing with a snap, devoured it with every sign of relish, and seemed eager for more.

One given to Capuchin (*Cebus* sp. *a*), which stuffed it into his mouth at once, chewed it, then hastily took it out again, apparently finding he had something either unusual or unpleasant on his tongue; smelt it, pulled it to pieces with his hands, and finally ate it, but with a good deal of doubt as if undecided as to whether it was nice or nasty.

July 5, 1909. One specimen offered to a Fantailed Flycatcher was immediately seized and pecked and tasted, and then rejected. The Shama then tried it, and treated it in the same way, finally rejecting it. A second Flycatcher then tasted it, and rejected it.

Another specimen of the moth let loose in this aviary flew through the wires into another compartment, and was captured on the wing by a Pied Grallina. He pecked it once or twice, and tasted it, then flew away. A Cuban Mocking Thrush then came up, and while he was looking at it and hesitating to peck, the Grallina came back, drove away the Mocking Bird, seized the moth and gradually ate it, holding it in one foot and pecking it to pieces.

Larva of Cinnabar Moth.

Aug. 15, 1909. Inspected but not touched by English Thrush.

Offered to many fowls, only one of which pecked it, but dropped it at once and took no further notice.

MAGPIE MOTH (*Abraxas grossulariata*).

Aug. 1909. Offered to fowls, was inspected by several, but only pecked by one, which at once dropped it, and made no further attempt.

Small Green Geometra larva, probably of *Cabera pusaria* or *exanthemaria*.

May 26, 1909. One taken without any hesitation by a Shama; but dropped. Then taken a second time, and dropped. When preparing to take it a third time, he was deprived of it by a Black-headed Sibia, which after spending a few seconds adjusting it in his beak, swallowed it. It appeared to me that the Shama dropped this larva accidentally, owing to lack of skill in adjusting it in his beak, rather than intentionally. He was just as eager to take it, although dead, the third time, as the first.

THE SWALLOW PROMINENT (*Pheasia dictæa* or *tremulæ*).

July 12, 1909. Flattened itself to the ground but was at once pounced upon by the same Flycatcher that had just eaten the Hemerobiid (see p. 835). The bird, without any hesitation, ate it with all speed, being merely delayed by the trouble of adjusting the wings. Both this moth and *Mamestra persicariæ* betrayed their identity as Lepidoptera by flying out of the boxes to the ground, so I had no chance of judging whether the Flycatcher or other birds would have been deceived by their procryptic coloration.

THE BUFF-TIP (*Phalera bucephala*) (imago).

July 5, 1909. Not being aware of this moth's propensity, I picked it up by the wings, whereupon it immediately twisted its abdomen round and ejected a stream of white fluid over my fingers. I regret that I missed seeing this defensive device practised on a bird. However, I placed the moth on a wooden branch, and a Fantailed Flycatcher flew down to inspect it; after loooking at it for a few seconds, he flew away. I then put it near a Shama, who hopped up to it and almost immediately picked it up by the thorax. The other birds in the aviary now became interested and pursued the Shama, giving him no chance of eating it. When on the wing he dropped the moth, and the Fantailed Flycatcher, which had previously taken no notice of it,

immediately pounced on it, and after one or two efforts swallowed it at a gulp.

My impression is that the Flycatcher did not suspect the moth of being eatable until he saw the Shama take it. It certainly looked very like an inanimate excrescence as it rested on the perch. Presumably the moth had exhausted its intestinal artillery upon me, because it shot out no more when seized by the birds, but kept perfectly quiet without even flapping its wings, although the Shama did not crush it, and having it end on by the thorax with the moth's head in his mouth, left the wings perfectly free to flap, and the abdomen to wriggle, had the moth been disposed to struggle. This behaviour, I take it, was a manifestation of the deeply implanted instinct to keep absolutely still (commonly called 'death-feigning'), which is so highly developed in many animals with procryptic shape and colour.

THE DOT (*Mamestra persicariæ*).

July 12, 1909. One flattened itself to the ground, and was seized by the Fantailed Flycatcher that had eaten *Pheasia tremulæ*, and was eaten with avidity, delay, however, being caused by the bird's desire to get rid of the wings as well as by being disturbed by another Flycatcher and a Syrian Bulbul, which tried to deprive him of the moth. The Bulbul subsequently picked up the pieces of wing and ate them.

Larvæ of the BRIGHT-LINE BROWN-EYE (*Mamestra oleracea*).

Oct. 26, 1909. One given to Harmonious Shrike-Thrush was taken after a moment's scrutiny. He pecked it, and tasted it three or four times, then swallowed it readily enough. His behaviour suggested to me a certain amount of caution at first, as if he remembered the distastefulness of the pupa of *Pieris brassicæ* which he had just previously eaten. The green hue of both gave them a superficial similarity to one another. Having eaten the one specimen of *oleracea* he was very keen to get the second.

This I gave to the Black-winged Grackle which a few minutes previously had unhesitatingly left the pupa of *P. brassicæ* after one taste. He took it, and after a taste or two proceeded to eat it with avidity, not giving the Shrike-Thrush, who was hovering near and following him up for an opportunity to snatch it, a chance to do so.

Larva of DRINKER (*Cosmotricha potatoria*).

May 26, 1909. One thrown to floor of aviary, was followed by many birds and secured by a female Black Tanager, which carried it to a perch and proceeded to peck it and shake it for about one minute. She then dropped it, and it was seized by the Black-headed Sibia, but was dropped at once. The Tanager thereupon tried it again; and again let it fall, this time almost

immediately. Two Fantailed Flycatchers then came up and inspected it. One of them pecked it, but let it alone after one experimental taste. The larva was by this time dead. Then a Sulphury Tyrant came up, picked it up and after a peck or two swallowed it.

Larva of *Noctua* (unidentified).

May 26, 1909. Two (fed on *Tropæolum*, so-called Nasturtium) eagerly eaten by Pekin Robin and by Kagu.

One (fed on cabbage) was readily eaten by Yarrell's Curassow, which had just rejected the larva of the Large White (*Pieris brassicæ*) and of the Small White (*P. rapæ*).

Order **NEUROPTERA**.

Hemerobiid (unidentified).

July 12, 1909. One turned loose in aviary was at once caught on the wing by Fantailed Flycatcher and eaten without hesitation. The bird wiped its beak two or three times on a branch afterwards; but I do not think this action can be regarded as a certain sign that it wished to remove something unpleasant. It suggests the possibility, however, especially in view of the fact that the action was not repeated by the same bird after greedily eating *Pheasia dictæa* and *Mamestra persicariæ*.

Large Black and Yellow Dragon Fly (*Cordulegaster annulatus*) male.

July 26, 1909. One pounced upon and eaten after a time by Harmonious Shrike-Thrush.

Order **ORTHOPTERA**.

Common Grasshopper (*Stenobothrus* sp.).

Sept. 6, 1910. One given to Pekin Robin was eagerly taken and eaten, but not with great rapidity, the bird putting it on the ground between the pecks, but without once shaking his head or showing any signs of disliking the taste. He appeared to me to be troubled by the insect's legs.

Great Green Grasshopper (*Locusta viridissima*).

All the birds in the aviary were keen to get it. It was tackled at once by a Dial Bird; but he was driven off by a Black Tanager, who flew away with the insect and pulled it to pieces on the top of a wall.

Sumatran Stick Insect (*Lonchodes* sp.).

Taken and eaten at once by:—Pinché Marmoset, Lion Marmoset, Douracouli, Capuchin, and Banded Mongoose.

Taken in the hand, but put down untasted and unhurt by Grey Lemur.

Taken and eaten at once by:—Silver Pheasant, Cartagenian Motmot, Fantailed Flycatcher, two Dial Birds, Shama, Black-chinned Laughing Thrush, two White crested Jay-Thrushes, Black-winged Grackle, Chinese Mynah, Brazilian Hangnest, and Shrike.

The Shrike was too shy to take the specimen from my fingers, so I threw it towards him on the sand, not seeing exactly where it fell. He, however, saw the direction of the falling insect, and hopped towards it, but somewhat to my surprise for birds seldom lose sight of thrown food—did not pick it up but looked as if inquiringly up at me. After a little search I found the small Stick Insect on the sand lying still with legs extended, and looking exactly like a blade of green grass. When I stirred it up and made it crawl, the Shrike was on to it in a moment; and I have no doubt that he missed it in the first instance owing to its resemblance to the grass blade.

I observed that several of the birds looked inquiringly, as I should describe it, at the Stick Insects before taking them. One in particular, the Harmonious Shrike-Thrush, usually one of the keenest insect-eaters in the Gardens, hesitated on two occasions so long before making up his mind to touch them that he was promptly robbed of his prey, once by a Dial Bird and once by the Black-chinned Laughing Thrush.

Two birds took them directly, but instead of eating them, hopped about with them in their beaks. One of these, the Green Hangnest, was deprived of his by a Chinese Mynah, which took it from him through the partition bars of the next aviary; the other, a Grey Struthidea, was similarly robbed by a White-crested Jay-Thrush after a Collared Jay-Thrush had made several attempts to get it from him.

Order **COLEOPTERA**.

Group GEODEPHAGA.

The species of this group used for the test belonged to the Carabidæ, a family of carnivorous ground-beetles with an exceedingly hard exoskeleton. *Carabus violaceus* is black with blue reflections; the species of *Pterostichus* are dead black and shine like pitch. *Harpalus* has pubescent elytra and is a little less conspicuous.

Carabus violaceus.

July 31, 1909. One rejected, after being smelt by three Meerkats, two Banded Mongooses, and one White-tailed Mongoose. The latter behaved towards it exactly as he did towards the *Ocypus olens* (see p. 838).

Offered same specimen to Harmonious Shrike-Thrush, which seized it eagerly but was robbed by the Dial Bird. I am sure by the way they tackled the beetle that either of these birds would have eaten it; but the Spotted Bower Bird robbed the Dial Bird, as in the case of *O. olens*, and finally finished it.

July 31, 1909. One dropped on to floor of cage of the Meerkat which had just eaten a *Timarcha tenebricosa*. He pounced on it, but would not seize it as he did the *Timarcha*. I think he bit it, but am not sure. However, by the way he pawed it about I am convinced he did not care for it. While he was holding and smelling it, he quite suddenly let it go and vomited up the *Timarcha* (see p. 841). The *Carabus* escaped unhurt. I then gave it to a Capuchin which seized it, and was proceeding apparently to eat it when another snatched it from him and ate it without showing any marked signs of dislike, but with no great avidity.

This species, like others of the genus *Carabus*, discharges from its mouth when handled a most repulsive smelling fluid.

Mr. Beddard found that *Lacerta ocellata* ate this beetle.

Pterostichus (*Abrax*) *striola*.

July 26, 1909. One taken by Sulphury Tyrant which shook it and pecked it for some time until robbed of it by Spectacled Thrush. This bird also pecked it and banged it about until robbed by female Black Tanager, which ultimately ate it after much pecking and tasting.

The delay in eating this beetle on the part of the birds that tried it may have been due to its hard exoskeleton or to partial unpalatableness from other causes. The hardness alone would, I think, account for it.

One (dead) given to Silver Pheasant was swallowed entire with very little delay. The bird, however, after taking the insect from my fingers, put it on the ground as is his custom with anything hard or with soft butterflies not quite to his liking.

July 31, 1909. One seized and bolted at once by Silver Pheasant in exactly the same way that he had bolted the other Carabidæ.

Pterostichus niger.

July 31, 1909. One smelt but rejected by three Meerkats; snatched from the forceps by a Common Indian Mongoose, which followed it and watched it, and smelt it as a cat does a cockroach, but did not eat it, so I took it from the cage uninjured. White-tailed Mongoose turned from it in disgust.

One seized and bolted at once by Silver Pheasant.

According to Mr. Beddard this beetle was eaten without hesitation by *Lacerta vivipara* and another lizard: and with some hesitation by Finches.

Pterostichus (*Steropus*) *madidus*.

July 31, 1909. One smelt and refused by three Meerkats. Seized and eaten by White-tailed Mongoose. This Mongoose is a large animal approaching a cat in size.

One seized and bolted by Silver Pheasant.

One pecked twice by Elliot's Pheasant, but escaped into the grass unhurt.

One seized and eaten by Black-headed Sibia.

Harpalus ruficornis.

July 21, 1909. One pecked at twice by Silver Pheasant but not eaten, the bird taking no further interest in it after the second peck. The beetle escaped unhurt.

Group Brachyelytra.

Devil's Coach-horse or Cock-tail Beetle (*Ocypus olens*).

(Uniformly velvety black in colour.)

July 31, 1909. One smelt and rejected at once by three Meerkats, one Mongoose, one Banded Mongoose, and by the White-tailed Mongoose that had just before eaten the *Timarcha* (see p. 842). This Mongoose started away from the scent in a way that reminded me of the behaviour of a person who finds a bottle of smelling salts unexpectedly pungent.

Offered the same specimen to Harmonious Shrike-Thrush, which tackled it at once, but while pulling it to pieces was robbed by the Dial Bird, and this bird in turn was robbed by a Spotted Bower Bird, which ate it.

Note.—The difference between the Viverrine mammals and the birds in their behaviour towards the Ground Beetles (Carabidæ and *Ocypus olens*) was very marked, and is to be in a measure explained, I think, by the wide difference in their powers of smell. The beetles appear to be relished by the birds; but to be nauseous to the mammalia. This perhaps is natural; because the Passerine birds would seldom come across the Ground Beetles, which are cryptozoic and largely nocturnal. The mammals like the Meerkats, and the Mongooses, on the other hand, must commonly find them as they grub about and hunt for food on the ground. Therefore one would expect protective attributes, if existing at all in these beetles, to be of a kind to guard them against being eaten by Meerkats or insectivorous mammals of similar habits.

The Silver Pheasant which ate these beetles is essentially a diurnal feeder and would seldom find nocturnal beetles. After seeing him eat the *Pterostichi* as if they were large seeds, I do not understand why he did not eat the *Harpalus ruficornis* offered to him some time previously *.

* Mr. G. A. K. Marshall suggested at the meeting when this paper was read that the *Harpalus* had retained while the *Pterostichi* had discharged their acrid juices.

Group Lamellicornia.

Dung Beetle (*Geotrupes vernalis*).

July 23, 1909. Offered to Pearl-spotted Owl, which blinked at it, but refused to touch it. Offered to a White-eared Scops Owl, was at once taken and held up in one foot; but after a few pecks, which removed some legs, it was let fall, no effort being made to recapture it. Given to a Ludwig's Bustard, was eagerly taken, and swallowed whole after a few pecks.

The large Cockchafer (*Melolontha vulgaris*).

July 23, 1909. One dropped on floor of aviary was pounced upon by Indian Dial Bird which had just before been trying the *Timarcha*. He pecked it, hammered it with his bill, and after a great deal of difficulty broke it in half. He evidently liked it, because he would not give any other bird a chance of getting it. However, when he had broken it up, the Harmonious Shrike-Thrush secured one half and carried it away, and after pecking it for a few minutes swallowed it. The Dial Bird in the meantime finished off his portion.

Stag Beetle (*Lucanus cervus*) male.

July 31, 1909. This I showed to some Capuchins, which evinced the greatest eagerness to secure it, but no sign of fear. I gave it to one, and his first act was to bite off the mandibles. This may have been an accident, but it reminded me of the alleged action of baboons in removing the stings of scorpions before they can do any damage with them. He then bit off the legs, finding they worried him, and sitting down munched up the beetle as if it had been a bit of apple. On a previous occasion I gave a dead Stag Beetle (male) to some Brush Turkeys. One seized it and was promptly chased round and round the enclosure by the others, which evinced the greatest keenness for a share. I could not wait to see what ultimately happened to the insect.

Group Longicornia.

Strangalia armata, the only species of this group experimented with, is a black and yellow, somewhat wasp-like flower-haunting diurnal beetle, with a very hard exoskeleton.

July 21 to 31, 1909. One taken at once from my hand by Silver Pheasant and eaten after a good deal of pecking and breaking up. The way the bird persevered with this hard-shelled beetle shows that his rejection of the *Harpalus* was not due to its hardness (p. 838).

One offered to Fantailed Flycatcher, which, however, would not touch it. Black-headed Sibia took it without hesitation, and flying away with it pecked it to pieces and finally ate it. Further

evidence of the bird liking the insect was shown by the way he flew away with it when chased.

One taken and eaten by Dial Bird, which was apparently only delayed in disposing of it by the hardness of the exoskeleton.

One taken and similarly disposed of by Great Barbet.

One eaten after being broken up and crushed by Brazilian Hangnest.

Group MALACODERMATA.

The beetle of this group used for the experiment is a flying diurnal flower-haunting species, with a soft exoskeleton. It is quite fearless of exposure. Beetles allied to it commonly form centres of mimetic attraction in the tropics.

TELEPHORID (? *Rhagonyche fulva*).

July 21, 1909. Four offered to four Capuchins were eaten, two readily and without examination, two after a good deal of tasting and examination between the tastes.

Two offered to two Capuchins were taken into the mouth, tasted, then taken out, wiped on the bars and left.

One refused by Ceylonese Macaque after being smelt.

One eaten by Mona Monkey after a good deal of tasting, smelling and pulling about. This Mona also ate the bug *Tropicoris rufipes* (p. 847).

One offered to Lion Marmoset was taken in the hand, smelt, and promptly dropped. The Marmoset then descended from the perch, picked it up again, smelt it and dropped it. The beetle crawled away unhurt.

One smelt once or twice by Meerkat, was rejected without being tasted.

One taken by Silver Pheasant, was pecked twice and left alone. Another offered to same bird was pecked once and left. One taken by Fantailed Flycatcher was pecked and tasted, then left. The same specimen was then pecked once or twice by a Shama and rejected. Black-headed Sibia then tried it, but gave it up and vigorously wiped his beak after a taste or two. Afterwards he made another attempt with the like result. The Black Tanager then took it, tasted it, wiped his beak and rejected it.

One caught on wing by Harmonious Shrike-Thrush was eaten after much pecking and pulling about. Another was treated in the same way by this bird.

Two specimens, one of which was dead, offered to and eaten by Dial Bird.

One tasted two or three times by Shama but rejected.

One pecked by Black-chinned Laughing Thrush, but flicked away. Pounced on and eaten by Dial Bird.

Although eaten by the Dial Bird and the Shrike-Thrush, which ate most of the insects offered to them, and by some of the

Monkeys, there can be no doubt that this soft-shelled beetle possesses distasteful attributes. Its rejection by the Meerkat, which ate nearly all the insects offered to it with the exception of *Coccinella 7-punctata*, was very significant, and suggestive of nasty smelling secretions.

Group Phytophaga.

The three species of this group that were tested are well-known species. They are slow-moving diurnal forms found on plants of different kinds. They are squat in shape, dorsally convex, and have a very hard exoskeleton, the Ladybird (*Coccinella*) being in addition exceedingly slippery and difficult to hold. The coloration of the latter is orange with black spots. The others are uniformly black or blue. *Timarcha tenebricosa*, the familiar 'bloody-nose beetle,' is further notorious for the discharge from its mouth of a crimson liquid, whence the trivial name is derived.

Chrysomela polita.

July 31, 1909. One offered to Meerkat was smelt and refused. Another Meerkat in the same cage took it in his mouth, but spat it out; both then sniffed it as it lay on the ground, but would not touch it.

The same specimen, offered to a Grison, was sniffed but not touched. Snapped up by McCarthy's Mongoose; but was at once spat out and left. It was then taken and eaten by a Banded Mongoose.

Query: Had the previous tasters exhausted the Beetle's supply of nauseous juices?

One given to Dent's Monkey was taken, rubbed between the hands and in the sawdust, smelt, tasted, pulled about and rejected. Picked up by Mona in the same cage, but rejected after one taste. This Mona had just eaten a living *Bombus*.

One given to Harmonious Shrike-Thrush was taken, pecked and tasted for a little, then left. Picked up by Black-chinned Laughing Thrush, was pulled to pieces, and rejected. This bird may have eaten pieces of the beetle, but the other débris was left on the turf. He did not appear to find it very unpalatable. Possibly in this case the nauseous juices had been exhausted by the Shrike-Thrush.

One pecked off a perch by Fantailed Flycatcher, but not followed up. Pecked and tasted by Sulphury Tyrant, but left. Then tried by Sun-Bittern, but also left, crushed but with nothing missing.

Timarcha tenebricosa (=*lævigata*).

July 23–31, 1909. One offered to a Meerkat was eagerly seized, chewed up and swallowed without much hesitation. But while this Meerkat was just afterwards occupied with the *Carabus violaceus* (cf. *supra*, p. 837), he vomited the *Timarcha*. I do not know

whether the sickness was caused by the smell of the *Carabus*, which to me is nauseating, or to its taste, or by the irritation of the stomach caused by the *Timarcha*. I suspect the latter, because the Meerkat refused to touch a second *Timarcha* that was offered to him.

One smelt and rejected untasted by two more Meerkats; taken by a third in the same cage, rubbed in the sawdust, but left apparently uninjured.

One grabbed at once and eaten by White-tailed Mongoose, which immediately afterwards heaved and went through the action of vomiting without, however, ejecting the beetle. A second specimen was smelt and rejected with every show of disgust by the same animal, which persistently refused for the next two hours every beetle that was offered him, although before eating the *Timarcha* he had devoured a *Pterostichus madidus*. One rejected without being closely smelt by a Banded Mongoose which had eaten a *Coccinella 7-punctata*. Seized by a second Banded Mongoose, and eaten after a good deal of rubbing in the sawdust.

One offered to a Capuchin, one of the specimens which had refused the Telephorid (*Rhagonyche fulva*) (p. 840), was taken, smelt, and rejected.

One offered to another Capuchin was ultimately eaten piecemeal, but with so much delay caused by handling, licking, and inspection, that I am sure it was no great treat to him, especially as he had every reason to eat it speedily because a bigger Capuchin in the same cage, which had snatched the *Carabus* from his grasp, was almost continually after him to get the *Timarcha*. When monkeys like their food they gobble it up if there is the least likelihood of another taking it.

One offered to a Vervet Monkey was accepted, pulled to pieces and eaten, the exoskeleton being dropped to the ground.

This specimen of *Timarcha* had been previously offered to a Baboon (*Papio sphinx*); but he would not even touch it.

One put on the floor of aviary was pounced upon by Dial Bird, which after continued pecking and hammering could make nothing of it beyond breaking it in half at the waist. Ultimately he left it. An Orange-headed Thrush then tried the abdomen, but was driven off by a Hoopoe, which after pecking and hammering it, gave it up. The Thrush then tried again, and also gave it up. A Black-chinned Laughing Thrush then had a turn; but with the same result.

One given to Harmonious Shrike-Thrush which had eaten the *Coccinella*. He persevered for a long time, but could not manage it and flew away, leaving the beetle apparently unhurt. After about five minutes the bird came back and tried again, this time pecking off the legs and antennæ of the beetle; but he would not eat the body, and at last flew away and returned no more.

Sept. 18, 1910. One female taken by Kagu, well crushed, then swallowed at a gulp.

One male taken by Vigors's Bustard, crushed and put down with a head-shake; then tasted by two Ludwig's Bustards, the three birds having alternate pecks at it, the Vigors's Bustard finally swallowing it.

One female well tasted, but rejected by Wood-Swallow, Black-winged Grackle, Javan Pied Mynah, and Black-chinned Laughing Thrush: also by Sun-Bittern, which persevered for a long time, repeatedly washing the beetle in the water-trough, and taking a drink at the finish.

Taken and pecked to pieces, and eaten bit by bit by Silver Pheasant. The bird wiped his beak several times on the earth, and for some little time afterwards stood opening and shutting his beak like a monkey or a human being getting the flavour of something tasty.

Some of the birds which tried to eat the *Timarcha* showed no special signs of finding them unpalatable. It appeared to me that they finally refused them on account of the hardness of the exoskeleton. Probably this prevented them getting at the softer tissues containing the flavour, whether unpleasant or otherwise.

Larva of *Timarcha tenebricosa*.
(A fat bluish-black grub.)

June 15 to 24, 1909. One eaten with apparent relish by Meerkat, which only delayed seizing it for about two seconds to rub it in the sawdust and smell it. This was the same Meerkat that on a previous occasion had eaten *Euchelia jacobææ* and rejected the *Coccinella*.

One taken at once by the same Capuchin that had eaten *E. jacobææ* and rejected *Coccinella*; but after crushing it between his teeth and getting the flavour, the monkey at once took it out in his hands, contemplated it for a few seconds, and moving his lips the while as if sampling the flavour, then letting it fall, retired to the back of his cage, salivated and heaved twice as if going to vomit.

Another Capuchin in the same cage now picked up the crushed larva, tasted it, and put it down; and neither of the monkeys touched it again. So I gave it to the Meerkat, which ate it as greedily as it did the first.

One given to Armadillo was eaten after a good deal of smelling. A second was eaten without hesitation.

One given to Dent's Monkey was eagerly taken and tasted, but almost at once dropped. The monkey did not taste it again, although he was interested in it and played with it for some little time.

One given to Mona Monkey, which behaved in much the same way as Dent's Monkey, but played with the larva for a longer time.

One given to Capuchin (sp. *a*) was taken and chewed up, but

just as I thought he was going to swallow it, he spat it out with profuse salivation.

One given to another Capuchin (sp. *a*) was licked and dropped.

One given to a third Capuchin (sp. *b*) was chewed up and swallowed without any signs of dislike, the larva being not even taken from his mouth for examination.

Another given to the same monkey was also eaten without any signs of dislike, although he held it in his hands and licked it several times before finally putting it into his mouth and chewing it.

June 24, 1909. Repeated experiments with monkeys.

The two Capuchins (sp. *a*), the Dent's and Mona Monkeys behaved exactly as before. They took the larvæ, smelt them, tasted them once or twice, and finally rejected them. The Capuchin (sp. *b*) which had previously eaten two, again ate one without signs of relish or the opposite. I then offered a larva to another Capuchin of the same species (*b*) and he treated it as the specimens of the species *a* and as the Mona had done, that is to say smelt it, tasted it, rubbed it in his hands, repeated the tasting once or twice, and finally dropped it. His behaviour showed that the difference between the behaviour of the first example of sp. *b*, which ate the larvæ, and that of the examples of sp. *a*, which rejected them, is not attributable to the specific distinction between the Monkeys as might have been supposed, if only one specimen of sp. *b* had been available for experiment.

One given to Canadian Jay, taken, pecked, jammed into a cranny, and repeatedly pecked; then dropped. When the bird made no attempt to fetch it, the keeper picked it up and placed it on the perch, when the bird again seized it, jammed it into a cranny in the perch, and left it.

One given to Red-backed Shrike was eagerly seized, and after one or two pecks was left, the bird retiring and wiping his beak on the bars, as the Canadian Jay had also done.

Two given to Silver Pheasant were taken and pecked, and after a good deal of rubbing in the earth were eaten.

One given to Prince of Wales' Pheasant was taken, pecked and rejected.

One given to Piping Crow was pecked and tasted and rejected, after a good deal of shaking of the head and wiping of the beak on the part of the bird. It was then picked up by a Magpie, which after a taste or two stowed it away under a large stone, and built up the hole with pebbles.

One given to Buff Laughing Kingfisher was taken and tasted, but rejected with much bill wiping. Tried and rejected in the same way by a second specimen of this bird.

One given to Common Laughing Kingfisher was taken and tasted, but finally rejected.

One given to Dial Bird was finally rejected after a great deal of pecking and tasting, accompanied by much shaking of the head and wiping of the bill.

One given to White-collared Crow was taken, tasted, carried about, and finally dropped. This bird refused to take a second specimen offered immediately afterwards.

One given to Hooded Crow was treated in exactly the same way as the one above-mentioned was treated by the White-collared Crow. This Hooded Crow also refused a second specimen.

One given to Wild Turkey was taken and pecked, but soon rejected.

SEVEN-SPOTTED LADYBIRD (*Coccinella 7-punctata*).

July 5, 1909. I offered one to the Capuchin which was the only one of these Monkeys to eat the *Timarcha*-larvæ, thinking he might be deficient in tasting powers. He took it at once from my fingers into his mouth, and crushed it between his teeth; but, presumably as soon as he got the flavour, removed it from his tongue with his fingers, and took no further notice of it.

I offered the remains to a Mona Monkey, but she only smelt them and pulled them to pieces, and would not taste them.

July 23 to 31, 1909. One was offered the Capuchin (sp. *a*) that had eaten the *Euchelia jacobææ* and *Bombus lapidarius* on the previous day, and had so far refused nothing in the way of Lepidoptera. He took it from my hands directly, transferred it to his mouth and crushed it; but instantly took it from his tongue, wiped it on the perch and left it without a second look. I then gave the crushed insect to the Meerkat that had eaten *E. jacobææ* and the *Bombus lapidarius*. He seized it at once, but just as promptly spat it out, gave his mouth a wipe with his paw, and never attempted a second taste.

One given to Vervet Monkey which had just eaten a *Timarcha tenebricosa* (see p. 842). She took it, smelt, licked and examined it thoroughly, rubbed it between her hands, then dropped it to the floor and took no further notice of it. I had previously offered this *Coccinella* to a Chacma Baboon. She smelt it but would not take it from my fingers.

One given to the Capuchin which on a previous occasion had tasted and rejected one. He took it, and after a great deal of smelling, tasting, rubbing between his hands and on the boards of the cage, finally ate it bit by bit, pulling it into many little pieces. This Capuchin had just before eaten a *Carabus violaceus*.

One smelt but refused by three Meerkats. Grabbed by Yellow Meerkat, tasted, but let go unhurt. Taken by Banded Mongoose, and eaten after much rubbing in the sawdust, and with many shakes of the head.

One offered to Grey Lemur, was smelt, taken in the hand and dropped.

Sept. 20, 1910. One taken and quickly eaten by Meerkat; but the same animal refused a second specimen.

One taken and rubbed about in the sand and repeatedly bitten,

and ultimately eaten by another Meerkat, but the same animal refused a second.

One taken in the paws by a Marsh Mongoose, but rejected after being repeatedly rubbed in the sand and smelt.

One taken by Banded Mongoose and crushed, but rejected with much head-shaking; swallowed by a second animal also with much head-shaking.

One refused after being smelt by three Yellow Meerkats.

One taken and licked by Capuchin, but rejected.

One licked but rejected by Red-handed Marmoset.

Another monkey of same species, and a Common Marmoset refused even to taste it.

July 23, 1909. One examined by Spectacled Thrush, but not touched. Pecked by Fantailed Flycatcher, which shook his head and left it. The bird returned three times, however, and pecked the beetle, but finally gave it up. I then offered it to a Shama three times in succession, and upon each occasion he flicked it away and made no attempt to follow it up. Next I tried the Harmonious Shrike-Thrush. He took it, and after a good deal of pecking, ate it.

July 31, 1909. Three eaten in succession by cock Silver Pheasant. The first one he took from my hand, but put it out of his beak on to the ground. After one or two pecks, however, he swallowed it. The others he took from my fingers and bolted entire as if they were grain, exactly as he had previously bolted the beetles, *Pterostichus niger* and *Ocypus olens*.

Sept. 20, 1910. One taken by Pearl-spotted Owl, but dropped at once.

One taken by a Pekin Robin, which after a few pecks and head shakes left it and took a drink of water; tasted by another bird of the same kind, but also left uneaten.

One taken and swallowed, after a deal of pecking about in the sand and head shaking, by another specimen of Pekin Robin, which had just previously eaten the grasshopper (*Stenobothrus*) and the bug (*Therapha hyocyami*).

One given to the Dial Bird that had just eaten a Humble Bee (*Bombus agrorum*). He took it at once, and after a little delay swallowed it whole.

N.B. This is the bird that rejected the two White Butterflies (*Pieris brassicæ* and *napi*) after tasting them.

One taken but rejected by Masked Wood-Swallow; then taken and eaten by Shama.

Two taken and bolted quickly by the same Shama, which showed no signs of objecting to the taste, except a single shake of the head on each occasion after swallowing the beetle.

Although some of these beetles were eaten both by mammals and birds, there can be no doubt that they were distasteful to the majority of the animals to which they were offered, even to some of those that ate them.

The interest of the demonstration of the distastefulness of *Coccinella 7-punctata* lies in the fact that Coccinellidæ of various kinds are mimicked in the tropics by insects of other orders, as well as by spiders.

Order **HEMIPTERA**.

Olive-brown Bug (*Tropicoris rufipes*).

July 21, 1909. One (dead) given to Mona Monkey was eaten after a great deal of handling, smelling and tasting.

One put on the ground was tackled by Fantailed Flycatcher, which pecked it some half dozen times. He was then driven off by a hen Black Tanager, which pecked it and pecked it again, and then left it. A Syrian Bulbul then flew up and tried it, but after persevering for some little time gave it up. Then the Tanager had another attempt, but left it. I then gave the mangled remains to the Harmonious Shrike-Thrush, and after a little pecking about he swallowed them.

One (living) eaten with very little delay by Silver Pheasant; but put on the ground after being taken from my hand. This specimen was immature on arrival; it moulted in the box, and was apparently adult when given to the bird.

One (dead) treated in the same way and eaten by the same bird.

Red and Black Bug (*Therapha hyocyami*).

Sept. 20, 1910. One given to Pekin Robin was at once taken and ultimately eaten; but the bird took a long time over it, putting it on the ground after each peck and vigorously shaking his head before tasting it again. The behaviour of this bird was exactly the same towards *Coccinella 7-punctata* (p. 846).

Order **DIPTERA**.

Bombus-like Fly (*Volucella bombylans*).

July 26, 1909. One taken by Fantailed Flycatcher but after being pecked and pulled about for some time, was left. The Sulphury Tyrant then tried it, but also left it alone after much pecking. Finally it was taken by Spectacled Thrush, which ate it after much pecking and wiping in the sand.

One given to Black-headed Sibia was eaten after a great deal of pecking and breaking up.

These experiments, as Dr. Longstaff reminded me, suggest that this fly is, at all events to a certain extent, unpalatable. If future tests should prove it to be so, its likeness to *Bombus* will be an instance of Müllerian rather than of Batesian Mimicry.

See also below, pp. 854–855.

Bombus-like Fly (*Arctophila mussitans*).

See below, pp. 851 and 853.

Fly like a small Bombus (*Chilosia illustrata*).

See below, pp. 854–855.

Spiny Fly (*Echinomyia ferox*).

July 31, 1909. One (dead) taken by female Tanager, but after a good deal of pecking, was left. A Black-headed Sibia then tried it and finally ate it.

One also eaten by Sulphury Tyrant (see below, p. 855).

Daddy Long-legs (*Tipula oleracea*).

Oct. 26, 1909. One taken from my hand and eaten readily by Dial Bird; one taken and eaten, but not so readily, by a second Dial Bird; one eaten greedily by Fantailed Flycatcher.

One of these specimens of Tipula was taken twice by the Harmonious Shrike-Thrush, but was dropped on both occasions. Another was taken three times by Black-winged Grackle, but was not eaten.

The rejection of this insect by the Shrike-Thrush, which ate almost every insect other birds refused, was very surprising.

Fly (*Empis tessellata*).

July 31, 1909. Two (dead). Eaten greedily by the Dent's Monkey that took the *Thanaos tages* with avidity (p. 831).

Order **HYMENOPTERA**.

Tipula-like Ichneumonid (*Ophion luteus*).
(Nocturnal species, mahogany-red in colour, with very tough integument.)

Oct. 26, 1909. One taken and tried perseveringly by Fantailed Flycatcher, but ultimately abandoned. Also tried but soon given up by Yellow-crowned Hangnest; taken and after a little pulling about swallowed entire by Dial Bird.

Nov. 7, 1909.—Taken by Black-winged Grackle; but so hard was the insect that it shot away out of his beak. The bird pounced on it at once on the sandy floor of the aviary and ate it; but if the insect had not been very lethargic, or if it had fallen amongst the undergrowth, it might have escaped him. Hence probably the significance of its hard slippery exoskeleton.

Larvæ of Saw-fly (*Cladius viminalis*).

These larvæ were yellow with black spots. They were sent to me by Mr. Taylor.

Aug. 19, 1910. Refused without tasting by Yellow-crowned Hangnest, Crested Bulbul, Blue-bird, and Fantailed Flycatcher.

Tasted but rejected by Black-winged Grackle, Harmonious Shrike-Thrush, Black-chinned Laughing Thrush, and Green Toucanet.

Taken by Greater Spotted Woodpecker, placed in a hole in a stump and hammered, but ultimately flicked away and lost.

Two taken and eaten after much pecking and tasting by a Shama. One eaten fairly readily by a Dial Bird; but another bird of the same species rejected a specimen after tasting and flicking it from his beak about twenty times.

Wood-Ant (*Formica rufa*).

May, 1910. Taken and eaten with avidity by the following birds:—Pearl-spotted Owl; Orange-headed Ground-Thrush; Dial Bird; Shama; Black-headed Sibia; Blue-bird; Pekin Robin; Harmonious Shrike-Thrush; Spotted Oriole; Larger Hill Mynah; Black-winged Grackle; Yellow-crowned Hangnest; Greater Spotted Woodpecker.

A Capuchin Monkey also ate one after another, picking them up in his hands and gobbling them as fast as possible.

Several specimens thrown into a cage containing three Wall Lizards were tasted by two of them, but rejected at once without being damaged in any way by the tasting.

Most of the birds showed no signs of objecting to the taste of the ants, or even of perceiving anything peculiar in their flavour. The Pearl-spotted Owl, however, shook his head, and the Spotted Oriole wiped his beak on the perch after eating them. The Pekin Robin and the Black-winged Grackle wiped the ants upon their wings, presumably to remove the formic acid. It is interesting to find the same device practised by two species so unlike one another.

I found that the birds, like the monkey, would eat as many of these ants as were given to them.

The unavoidable conclusion that these insects are palatable is rather surprising in view of the frequency with which ants of different kinds are mimicked in the tropics by Orthoptera, Coleoptera, and other insects, as well as by spiders. Nevertheless, it corroborates the opinion put forward by McCook and amplified and endorsed by myself in 1909 *, before these experiments were made, that ant-mimicry is mainly serviceable as a protection against the predatory Hymenoptera of the family Pompilidæ, which provision their nests with Arthropoda of various kinds, excepting ants, and are certainly the direst enemies that spiders possess.

* Journ. Linn. Soc., Zool. xxx. pp. 265–268.

Saw-fly (*Allantus arenatus*).

July 21, 1909. One eaten by Mona Monkey fairly readily; by Capuchins readily; by the Capuchin which on the previous day had refused the Malacoderm Beetle (*Rhagonyche fulva*); smelt, but not tasted by Lion Marmoset.

One eaten fairly readily by Harmonious Shrike-Thrush; by Shama readily; by Silver Pheasant; refused without tasting by Wild Turkey.

Honey-bee (*Apis mellifica*). (Workers.)

May 8, 1911. One offered to Silver Pheasant was taken from the forceps but immediately flicked away; the bird persevered, however, and after much pecking and flicking about of the insect, and wiping his bill on the ground, finally ate it.

One offered to Bornean Fire-backed Pheasant was inspected carefully but rejected untasted.

One given to Pekin Robin was taken at once, but was quickly flicked away. When pursued, however, by other birds in the cage, the Pekin Robin pounced on the bee again and flew away with it. Whenever he got a moment's peace, he put it on the ground, pecked and flicked it about, wiping it now and again in the sand and repeatedly shaking his head. At length he flew to a branch, and holding the bee against it with his foot, pulled it in two pieces, dropping one piece to the ground. He still persevered with the other piece, however, but I finally lost sight of him and do not know whether he ate it or not.

One given to a Cayenne Tanager was taken and chewed for a long time; the remains, however, were finally jammed into a banana and left.

One taken by a Blue Tanager which, however, allowed himself to be robbed without resistance or flight by a Maroon Tanager. This bird, after a deal of mastication, ate the bee.

One given to Wall Lizard was eagerly seized, but was left after one or two attempts.

Another was twice darted at by another lizard of this species, but was left alone the moment the lizard touched it. It was then boldly seized by a third lizard, which with one bite disabled the bee by crushing the head and thorax. This lizard persevered for about seven minutes, biting at the bee, but stopping after each bite to lick his mouth with his tongue and rub it against the moss. Finally he gave it up and went away.

Two Bluebottles (*Calliphora vomitoria*) and a Hover-fly (*Syrphus*) given as a check experiment were seized and eaten in a few seconds by the same lizards.

Humble Bee (*Bombus agrorum*).

(See also *infra*, p. 853.)

Oct. 26, 1909. One eaten with avidity by Capuchin and by Meerkat.

One given to Collared Jay-Thrush, which pecked it about and scraped it in the sand for a long time, wiping his beak in the intervals, and ultimately left it. It was then picked up by a White-crested Jay-Thrush, which treated it for some time in the same way, but at last ate the mangled remains. This same bird then took a specimen of the mimetic fly *Arctophila mussitans*, but made just the same fuss over the eating of it as he had in the case of the bee.

Sept. 18, 1910. One taken at once by Dial Bird, and after a good deal of pulling about, pecking and wiping in the sand, was eaten. This bird had just previously eaten a small Tortoiseshell Butterfly, and he took about the same time to finish off the one insect as the other.

Sept. 20, 1910. One offered to Dial Bird was taken at once and eaten with very little delay, after being wiped once or twice in the sand. The bird flew away with a second specimen and I did not see what became of it; but he returned to me, and I had difficulty in keeping him away from the bees with which I was experimenting with other birds.

This Dial Bird was the one that ate the same species of Humble Bee two days previously.

Humble Bee (*Bombus ? joncellus*).

July 31, 1909. One offered alive to Mona Monkey was snatched at once and eaten bit by bit.

Humble Bee (*Bombus ? terrestris*).

July 31, 1909. One (dead) taken by Brazilian Hangnest and pecked to pieces, the bird holding it the while in his foot against the perch. The pieces pecked off were dropped about the cage and not eaten.

Humble Bee (*Bombus lapidarius*).

May 31, 1909. One dead specimen given to the Meerkat was eaten bit by bit, after being rubbed in the sawdust by the animal's paws.

One dead specimen given to Capuchin (*Cebus* sp. *a*) was taken in the hands and eaten bit by bit, just as the Monkey would eat a piece of hard biscuit or sugar. Neither of these mammals showed any signs of disliking the taste of the bees; quite the contrary. Their molar teeth are evidently much better adapted for crushing the chitinous exoskeletons than are the beaks of the birds that tasted them.

One dead specimen offered to Syrian Bulbul was taken after about a minute's inspection. The bird pecked it and pulled it about for at least five minutes and dodged away with it from other birds that chased him. He grew, however, less and less

keen, and ultimately allowed a female Black Tanager to rob him of it. The Tanager behaved in just the same way, pecking and pulling it about and breaking it to pieces, but gradually losing her interest. At last she picked up a piece of the thorax and flew to a bush with it, leaving the remainder on the ground. I could not see what became of the piece she flew away with, but she emerged from the bush without it, and wiped her beak on a perch. She made no attempt to go back to the bits on the ground. A Sibia tried these, but after a peck or two left them, and no other insectivorous bird in that compartment took the least notice of them. So I picked up the abdomen and gave it to the Harmonious Shrike-Thrush which had just finished off the example of *B. hortorum*, mentioned below, and he ultimately ate it after a great deal of pecking and pulling about.

Humble Bee (*Bombus hortorum*).

May 31, 1909. One living example fell to the ground of the aviary when first liberated. Two Fantailed Flycatchers flew down to it at once, but although interested would not touch it; while they were hesitating the bee took wing and escaped, none of the birds in the aviary making any attempt at pursuit.

One dead specimen offered to a Shama. She allowed me to hold it close to her beak, but would not touch it. None of the other birds in the aviary would notice it when thrown to the ground, though on a previous occasion they had shown great eagerness in seizing dead butterflies. I then gave it through the bars to the Harmonious Shrike-Thrush in the next compartment. After pecking and pulling it about for six or seven minutes, he ultimately ate it.

July 31, 1909. One sniffed at but rejected by two Meerkats; taken by a third and eaten.

One pecked and flicked away by Black-headed Sibia, by Shama and also by Sun-Bittern, each making two or three attempts. Then carried off by female Black Tanager, but dropped to the floor, where a North American Cat-bird tried it once or twice, but gave it up. (The remains were now too mangled to be useful for further experiment.)

I could not induce the Fantailed Flycatcher to take any notice of this bee.

Conclusion. These experiments indicate that the Humble Bees used for the tests were much more palatable to the mammals than to the birds. With the exception of the one example of *B. lapidarius* which was smelt and left untouched by two Meerkats, all the bees offered to the Monkeys and Meerkats were eaten without any kind of dislike of the flavour being evinced. The Meerkat that rubbed the *B. lapidarius* in the sawdust did so, I suspect, to remove some substance offensive to his sense of smell. On the other hand, of the birds to which the bees were offered only three

ate them, namely a Dial Bird, a Jay-Thrush, and a Shrike-Thrush. The Dial Bird ate one quickly with only one or two wipes in the sand. In the other cases there was a great deal of pecking and wiping before the insects were finally disposed of. From the behaviour of the birds there could be no doubt that there was something in the bees not to their liking, even to those that ultimately ate them. The Bulbul, Sibia, and Tanager were obviously keen to eat them, and gave them the fullest possible trial before finally rejecting them; but whether it was the hairs, or the hard chitin, or the flavour, or a combination of them that made the insects unpalatable, I do not know.

Further experiments demonstrating the distastefulness of Humble Bees to birds of different kinds are given in the following section:—

Experiments to test the significance of the resemblance between Humble Bees (*Bombus*) and the Flies *Arctophila mussitans*, *Volucella bombylans*, and *Chilosia illustrata*.

Bombus agrorum and *Arctophila mussitans*.

Oct. 26, 1909. Offered Bee to a Lion Marmoset which was busily catching house-flies and bluebottles in his cage. He looked at it, but would not touch it. I then offered the fly, but he also refused to touch it. He did not, however, hesitate to take a Red Admiral offered a moment afterwards.

Offered Bee to Leach's Laughing Kingfisher. He took it at once, but soon flicked it away. Six times in succession he took it from my fingers and dropped it on each occasion. I could not induce him to take it again. Instead he started pecking my fingers. Thereupon I offered him the fly, and he just as resolutely refused to take it.

Offered Bee to Kagu, a New Caledonian Rail. He inspected it, and after a little hesitation tasted it. But he would not touch it again; and when offered the fly, refused that likewise.

Offered Bee to Central American White-browed Partridge. He took it without hesitation, but after a peck or two left it and went away. I then threw it to him, and he tasted it again; but would not eat it. I then threw him the fly, but he would not touch it.

A Douracouli (a South-American monkey); a Honduras Turkey; a cock and a hen Reeves's Pheasant, and three hen Silver Pheasants refused to touch both bee and fly, though they inspected them intently for a few seconds.

Sept. 20, 1910. Bee offered to Hoopoe was taken at once and tasted without being crushed, but was then left on the ground uneaten. The bird refused the next one I offered, and then refused to take the fly, although he stretched his head towards it and inspected it.

Bee offered to Yellow-crowned Hangnest, which took it at once, but soon dropped it. A second time he took it, and dropped it.

The third time it was offered he refused it, and immediately afterwards refused the fly.

Bee offered to Sulphury Tyrant. I importuned the bird into taking it from my fingers no fewer than eight times, and each time he flicked it away. The ninth time he refused to take it, and then refused the fly.

Bee offered to Black-winged Grackle, which took it at once, but dropped it. Twice more he took it and the last time flew a short distance away and persevered with it for about three-quarters of a minute, then leaving it returned to me; he refused the next bee I offered, and then refused the fly.

Bee offered to Silver Pheasant was at once taken, put on the ground, pecked and crushed almost past recognition, but left uneaten. The bird then took from my fingers three more specimens in succession, but dropped them uncrushed from his beak at once. The fifth he looked at, but would not touch, and then also refused the fly after inspecting it.

The experiments described above with the Lion Marmoset, the Douracouli, the Turkey, and the Reeves's and Silver Pheasants, which would not touch either the bee or the fly after some seconds of intent inspection, do not prove that the bee was known to be distasteful, and that the fly was rejected in consequence. That may be the explanation. The Douracouli, however, is nocturnal and probably does not naturally feed upon diurnal-flying insects. In the case of the Marmoset, the experiment does, however, suggest very forcibly that the *Arctophila* was not recognised as closely allied to the bluebottles the animal was hunting. The other experiments speak for themselves.

Bombus hortorum, *Volucella bombylans*, and *Chilosia illustrata*.

July 31, 1909. Offered living *Bombus hortorum* to the Brazilian Hangnest that had just pulled the dead *Bombus terrestris* to pieces. He took it directly, but instantly flicked it away and wiped his beak. The bee then crawled up the bars of the cage, and he again pecked and flicked it away. It was now too injured to crawl although still alive, so I picked it up and offered it in my fingers. He took it again and flicked it away. Twice more the trial was made, with the same result, although he was patently tiring of the trials. The next time he refused to touch it after inspection. I then substituted a dead *Volucella bombylans*. He inspected it, but did not touch it, and hopped up to the top perch.

I then offered the nearly dead *Bombus* to another specimen of the same bird. He took it from my fingers three times in succession, and each time flicked it away. The fourth time he refused to touch it. I then substituted the same specimen of *Volucella bombylans*, but after looking at it he would not take it.

I then again offered the *Bombus* to the first Haugnest. He took it and flicked it away, and immediately afterwards refused to touch the *Volucella*.

Next day I offered the first Haugnest a *Bombus* again; he took it from me three times, and flicked it away without attempting to eat it, but immediately afterwards took *Chilosia illustrata* and ate it.

The second Haugnest took a dead *Bombus*, and flicked it away, and then ate *Chilosia illustrata*, but refused immediately afterwards to touch a live *Bombus hortorum*.

Offered *Bombus hortorum* to North American Cat-bird, which came up to me on seeing other birds being fed. He pecked it several times, but flicked it away and gave it up. During the next quarter of an hour I could not induce him to touch either *Volucella bombylans* or *Chilosia illustrata*.

I then offered the *Bombus* on the forceps to a Sulphury Tyrant. He pecked and flicked it away several times, then left it, and refused it when offered again. I then offered him the *Volucella bombylans* both in the forceps and by throwing it to him on the ground, but he would not touch it. After a little hesitation, however, he took an *Echinomyia ferox* from the forceps and ate it, and then took and ate *Chilosia illustrata*. I then offered him *Bombus hortorum* again, and he took it but soon rejected it, and immediately afterwards refused to touch *Volucella bombylans*.

One *Bombus hortorum* offered to a Shama, which pecked it once or twice, and flicked it away each time. He then refused to touch the specimen of *Volucella bombylans*.

Tried the experiment with another Shama, which behaved in exactly the same way towards the bee, and would not afterwards touch the *Volucella bombylans*.

One *Bombus hortorum* offered to Silver Pheasant was taken at once, but left after some pecking and tasting. Then without hesitation he took *Chilosia illustrata* from the forceps and ate it; and promptly tried the *Bombus* again as it lay on the ground, but would not eat it. Immediately afterwards he eagerly ate an *Ocypus olens* and three specimens of *Pterostichus* (see pp. 837–838).

I made one *Volucella bombylans* do duty for all the experiments described above and had it intact at the end. It was not pecked by any of the birds, presumably because I never offered it to one until he had tried *Bombus hortorum* a sufficient number of times to reject it as unpalatable; and there is no doubt in my opinion that they did not distinguish between the bee and the fly. Although *Chilosia illustrata* is also very like *Bombus*, the difference in size is well marked. I suspect that in this circumstance lies the explanation of the birds not confusing this species of fly with the bee. They could judge the difference in size quite easily, because the insects were held at the same distance from them.

List of the Mammals, Birds, and Reptiles used for the Experiments.

MAMMALS.

Mona Monkey (*Cercopitheous mona*), Nigeria. Diana Monkey (*Cercopithecus roloway*), Gold Coast and Guinea. Dent's Monkey (*Cercopithecus denti*), Ituri Forest. Vervet Monkey (*Cercopithecus pygerythrus*), Cape Colony. Yellow Baboon (*Papio sphinx*), Nigeria. Ceylonese Macaque (*Macacus pileatus*), Ceylon.

Although feeding mostly upon fruits, roots, and vegetables of various kinds, all the Monkeys of the Old World eat insects as well.

Capuchins (*Cebus*, spp. ?).

Several immature specimens, belonging to undetermined species inhabiting the forests of the northern parts of South America.

Douracouli (*Nyctipithecus trivirgatus*).

A nocturnal Monkey from the Amazons.

Lion Marmoset (*Leontocebus rosalia*). Pinché Marmoset (*Leontocebus œdipus*). Red-handed Marmoset (*Leontocebus rufimanus*). Common Marmoset (*Callithrix jacchus*).

Although vegetable feeders in the main, the South American Monkeys and Marmosets seem more addicted to an insect diet than the Monkeys of the Old World.

Grey Lemur (*Hapalemur griseus*). Crowned Lemur (*Lemur coronatus*). Black Lemur (*Lemur macaco*). White-fronted Lemur (*Lemur fulvus albifrons*). Mongoose Lemur (*Lemur mongoz*).

Lemurs inhabit Madagascar. They do not appear to be partial to insects.

Suricate or Meerkat (*Suricata suricatta*).

Cape Colony. Feeds on small animals of various kinds and particularly insects and their grubs (*W. L. Sclater*).

Yellow Meerkat (*Cynictis penicillata*).

Cape Colony. Feeds on small birds, mammals, eggs, and insects (*W. L. Sclater*).

Banded Mongoose (*Crossarchus fasciatus*).

South and East Africa. Feeds on insects, fruits, seeds, eggs, snails, etc., according to Böhm.

Common Indian Mongoose (*Mungos mungo*), from India, and McCarthy's Mongoose (*Mungos fulvescens*), from Ceylon, live on small mammals, birds, reptiles, insects, and fruit. The White-tailed Mongoose (*Mungos albicauda*), from Africa south of the

Sahara, does not, so far as is known, differ in diet from the other species just mentioned.

Marsh Mongoose (*Mungos galera*).

West and South Africa. An amphibious species feeding mainly it is alleged upon crabs, fishes, frogs, and insects.

Grison (*Grison furax* = *Galictis vittata*).

A musteline carnivore from the Argentine, feeding upon small mammals and birds but also fond of fruit.

Common Armadillo (*Dasypus villosus*).

Argentine. Feeds on insects, grubs, worms, carrion, and vegetable matter.

BIRDS.

Cape Robin-chat (*Cossypha caffra*).

Range. East Africa to Cape Colony.

Food. Chiefly insects, spiders, and worms; also berries and small fruit (*Sclater & Stark*).

Common Thrush (*Turdus musicus*).

Range. Palæarctic Region, locally migratory.

Food. Insects, worms, fruit, etc.

Orange-headed Ground-Thrush (*Geocichla citrina*).

Range. The Himalayas up to 5000–6000 ft., Assam and Tenasserim.

Blue Rock-Thrush (*Geocichla* (*Monticola*) *cyanus*).

Range. From South Europe and North Africa to Turkestan, Tibet, the Himalayas, and Burma.

Common Rock-Thrush (*Geocichla* (*Monticola*) *saxatilis*).

Range. C. & S. Europe to C. Asia, N.E. Siberia and N. China.

Wood-Thrush (*Hylocichla mustelina*).

Range. Eastern North America, Central America to Guatemala.

Dial Bird (*Copsychus saularis*).

Range. Ceylon, India, ascending the Himalayas up to 5000 ft.; Burma and Tenasserim.

Shama (*Cittocincla macrura*).

Range. Ceylon, India and Burma.

Blue-bird (*Sialia sialis*).

Range. Eastern North America to a little west of the Missouri River.

Food. Insects of various kinds; also ripe fruits.

American Cat-bird (*Galeoscoptes carolinensis*).

Range. South-eastern United States to the Missouri, migrating southwards in the winter.

Food. Insects, fruit and seeds.

Mocking Bird (*Mimus polyglottus*).

Range. Southern United States from the Atlantic to the high central plains; locally migratory.

Food. Insects and fruit.

Cuban Mocking Bird (*Mimus orpheus*).

Range. Jamaica, Porto Rico, Haiti, Cuba.

Saturnine Mocking Bird (*Mimus saturninus*).

Range. Brazil.

Great Tit (*Parus major*).

Range. Widely distributed in the Palæarctic Region. Locally migrating but mostly resident.

Food. Insects and seeds.

Pekin Robin (*Liothrix luteus*).

Range. Himalayas from Simla to Bhutan; extending also into China; resident.

According to E. W. Oates the food of this bird consists of berries, fruit, seeds, and insects.

Pied Grallina (*Grallina australis*).

Range. Australia, generally distributed.

Food. Insects (*Gould*).

White-eared Bulbul (*Pycnonotus leuconotus*).

Range. Persia; Sind, the Punjab, the N.W. Provinces of India, and Central India as far east as Hoshargabad.

White-cheeked Bulbul (*Pycnonotus leucogenys*).

Range. Afghanistan; the Himalayas from Murree to Bhutan, up to 7000 ft.

Red-vented Bulbul (*Pycnonotus hæmorrhous*).

Range. Ceylon; India roughly to the foot of the Himalayas.

According to E. W. Oates the Indian species of Bulbuls feed chiefly upon fruit.

Syrian Bulbul (*Pycnonotus xanthopygus*).

Range. N.E. Africa, Arabia, Palestine, Cyprus.

Black-crested Bulbul (*Otocompsa flaviventris*).

Range. Nepal to Cochin China.

In the course of my experiments I noticed that Bulbuls of different species were very keen on butterflies; of beetles and crawling insects generally they took little if any notice; but the moment a butterfly was let loose in the aviary they were all on the move. From this I infer that they are great butterfly-hunters in their own countries.

Orange-headed Laughing Thrush (*Trochalopteron erythrocephalum*).

Range. Himalayas, from Chamba to Nepal up to 7000 ft.

Black-chinned Laughing Thrush (*Trochalopteron nigrimentum*).

Range. Himalayas from Nepal to Assam (7000 ft.).

According to E. W. Oates the food of the Laughing Thrushes (*Trochalopteron*) is the same as that of the Jay-Thrushes (*Garrulax*).

Spectacled or Melodious Jay-Thrush (*Trochalopteron canorum*).

Range. China; Shanghai, Amoy, Fokien, Chekiang.

Black-headed Sibia (*Sibia capistrata*).

Range. Himalayas from Hazára to Bhutan, 5000–8000 ft.; resident.

Collared Jay-Thrush (*Garrulax picticollis*).

Range. China: Chekiang, Fokien.

White-crested Jay-Thrush (*Garrulax leucolophus*).

Range. Himalayas to Assam and Burma in the hill-tracts.

According to E. W. Oates the Indian species of *Garrulax* feed upon every sort of insect and smaller reptiles, and probably also on fruit.

Grey Struthidea (*Struthidea cinerea*).

Range. South-eastern Australia; resident.
Food. Insects, particularly beetles.

Spotted Oriole (*Oriolus maculatus*).

Range. Sumatra, Java, Borneo.

Harmonious Shrike-Thrush (*Collyriocincla harmonica*).

Range. Australia; N. S. Wales and S. Australia.
Food. Insects (*Gould*).

White-eyebrowed Wood-Swallow (*Artamus superciliosus*).

Range. Interior of South Australia.
Food. Insects (*Gould*).

Masked Wood-Swallow (*Artamus personatus*).

Range. South Australia, locally migratory.
Food. Insects (*Gould*).

Red-backed Shrike (*Lanius collurio*).

Range. Europe, migrating in the autumn and winter into Western India and to South Africa.
Food. Insects; small birds etc.

Fantailed Flycatcher (*Rhipidura tricolor*).

Range. Australia, widely distributed.
Food. Insects of various kinds (*Gould*).

Garrulous Honey-eater (*Myzantha garrula*).

Range. South Australia, Tasmania.
Food. Honey and insects (*Gould*).

Black Tanager (*Tachyphonus melaleucus*).

Range. Costa Rica through Panama, Venezuela, Ecuador to Bahia.

Scarlet Tanager (*Rhamphocœlus brasilius*).

Range. South-eastern Brazil.

Cayenne Tanager (*Calliste cayana*).

Range. Guiana, Venezuela, Ecuador, Peru.

Green Hangnest (*Ostinops viridis*).

Range. Guiana, Brazil, Ecuador.

Yellow Hangnest (*Cassicus persicus*).

Range. Trinidad, Guiana, Ecuador, Bolivia, Brazil.

Common Hangnest (*Icterus vulgaris*).

Range. Colombia, Venezuela.

Brazilian Hangnest (*Icterus jamaicai*).

Range. North Brazil.

Yellow-crowned Hangnest (*Icterus chrysocephalus*).

Range. Guiana, Venezuela, Ecuador, Brazil.

Larger Hill Mynah (*Gracula intermedia*).

Range. India: the south-eastern Central Provinces, the lower ranges of the Himalayas from Kumaon to Assam, thence into the Malay Peninsula.

Small Hill Mynah (*Gracula religiosa*).

Range. Ceylon and Southern India.
According to E. W. Oates these two species of Mynah are resident or only locally migratory and live exclusively upon fruit.

Chinese Mynah (*Acridotheres cristatellus*).

Range. China: Shanghai, Hainan, Formosa; Philippine Islands.

Pied Mynah (*Sturnopastor contra*).

Range. Central and South India to Assam and Burma.

Javan Pied Mynah (*Sturnopastor jallæ*).

Range. Sumatra, Java, Borneo.

Black-winged Grackle (*Graculipica melanoptera*).

Range. Java.

Spotted Bower Bird (*Chlamydodera maculata*).

Range. New South Wales.

Food. Principally fruit and grain (*Gould*).

King Bird of Paradise (*Cicinnurus regius*).

Range. New Guinea.

Food. Fruit and insects.

Canadian Jay (*Perisoreus canadensis*).

Range. Canada and the Northern States of the Union.

Food. Insects; eggs, flesh; leaves of fir trees (*Audubon*).

Hooded Crow (*Corvus cornix*).

Range. Palæarctic Region.

Food. Omnivorous (eggs, carrion, young birds, etc.).

White-collared or Pied Crow (*Corvus scapulatus*).

Range. Africa south of the Sahara.

Food. Omnivorous, with partiality for flesh food.

White-backed Piping Crow (*Gymnorhina leuconota*).

Range. S. Australia, New South Wales.

Food. Mostly insects (*Gould*).

Long-billed Butcher Crow (*Cracticus destructor*).

Range. Australia.

Food. Chiefly insects.

Sulphury Tyrant (*Pitangus sulphuratus*).

Range. Guiana, Ecuador, Peru, Brazil.

Food. Mostly insects and animal food of various kinds as well as fruit.

Greater Spotted Woodpecker (*Dendrocopus major*).

Range. Palæarctic Region.

Food. Insects.

Common Laughing Kingfisher (*Dacelo gigantea*).

Range. New South Wales and South Australia.

Leach's Laughing Kingfisher (*Dacelo leachii*).

Range. North-east coast of Australia.

Buff Laughing Kingfisher (*Dacelo cervina*).

Range. East and North Australia.

Food. These great Kingfishers feed mainly upon reptiles and insects, but also upon rats and mice.

Elate Hornbill (*Ceratogymna elata*) and
Black Hornbill (*C. atrata*).

Range. W. Africa, Nigeria, etc.

Food. Insects; snakes, small mammals, etc.

Ground Hornbill (*Bucorax abyssinicus*).

Range. North Africa south of the Sahara.

Food. Insects, snakes, frogs, lizards (Stark and Sclater writing of the closely allied southern species *B. caffer*).

Hoopoe (*Upupa epops*).

Range. Southern Palæarctic Region from Scandinavia and the British Islands to Japan, migrating in winter to North Africa, Arabia and India.

Food. Ground insects, beetles, grasshoppers and ants.

Cartagenian Motmot (*Momotus subrufescens*).

Range. From Panama, Colombia, and Venezuela to Matto Grosso.

Great Barbet (*Megalæma virens*).

Range. China and Upper Burma.

Levaillant's Barbet (*Trachyphonus caffer*).

Range. S. Africa, Natal, the Transvaal, Rhodesia, etc.

Food. Fruits, berries, leaves, and insects such as termites (*Stark & Sclater*).

Green Toucanet (*Aulacorhamphus sulcatus*).

Range. Venezuela; Colombia.

Pearl-spotted Owl (*Glaucidium perlatum*).

Range. Africa south of the Sahara.

Food. Mostly insects (grasshoppers, termites); also mice and lizards (*W. L. Sclater*).

White-eared Scops Owl (*Scops leucotis*).

Range. Africa south of the Sahara to the Orange River.

Food. Chiefly insects, like grasshoppers; also rats and mice (*W. L. Sclater*).

Prince of Wales Pheasant (*Phasianus principalis*).

Range. North-western Afghanistan and North-east Persia.

Reeves's Pheasant (*Phasianus reevesii*).

Range. Mountains of Northern and Western China, extending as far east as Kiu-Kiang.

Elliot's Pheasant (*Calophasis ellioti*).

Range. Mountains of South-eastern China.

Silver Pheasant (*Gennæus nycthemerus*).

Range. South China, Fokien and Chekiang.

Vulturine Guinea Fowl (*Acryllium vulturinum*).

Range. East Africa from the Pangani River westwards to Kilimanjaro and northwards to Somaliland.

Pucheran's Guinea Fowl (*Guttera pucherani*).

Range. East Africa: Zanzibar to the Tana River and thence westwards into the interior.

N. American Wild Turkey (*Meleagris americana*).

Range. Formerly widely distributed in the United States of America. Not migratory.

Food. Beechnuts, acorns, berries, green-shoots, etc.; also grasshoppers, and other insects (*Bendire*).

Honduras Turkey (*Meleagris ocellata*).

Range. Central America: Guatemala, Yucatan, Honduras.

Food. Probably of a similar nature to that of *M. americana*.

Long-tailed Partridge (*Dendrortyx leucophrys*).

Range. Highlands of Guatemala and Costa Rica (*Ogilvie-Grant*).

Brush Turkey (*Catheturus lathami*).

Range. North-east and East Australia.

Crested Curassow (*Crax alector*).

Range. Northern part of South America: British Guiana, Colombia, Rio Negro, etc.

Globose Curassow (*Crax globicera*).

Range. Central America: Western Mexico to Honduras and Cozumel Island.

Yarrell's Curassow (*Crax carunculata*).

Range. South-eastern Brazil from Rio Janeiro to Bahia.

Red-tailed Guan (*Ortalis ruficauda*).

Range. Venezuela and the island of Tobago.

Most Game-birds, especially when young, eat insects as well as grain, nuts, and green-food.

Australian Bustard (*Eupodotis australis*).

Range. South and Western Australia.

Food. Seeds, vegetables, grasses, and insects (*Gould*).

Vigors's Bustard (*Otis vigorsii*).

Range. S. Africa: Cape Colony, Natal, etc.

Food. Seeds, insects, small reptiles (*Stark & Sclater*).

Ludwig's Bustard (*Otis ludwigi*).

Range. S. Africa: Cape Colony, Natal, Orange River Colony, S. Transvaal; partially migratory within this area.

Food. Mostly beetles, caterpillars, and other insects (*Stark & Sclater*).

The food of Bustards is probably much the same everywhere. The diet is essentially mixed, and consists of grain, green-shoots and leaves insects, small mammals (mice) and reptiles.

Two-striped Thickknee (*Œdicnemus bistriatus*).

Range. Mexico through Central America to Venezuela.
Food. Insects, worms, snails, etc.

Trumpeter (*Psophia crepitans*).

Range. Brazil.
Food. Fruits, seeds, insects.

Cariama or Seriema (*Cariama cristata*).

Range. South-east Brazil.
Food. Reptiles and small mammals for the most part.

Abbott's Rail (*Rallus abbotti*).

Range. Assumption Island.

Black-tailed Water-hen (*Tribonyx ventralis*).

Range. Australia, south of the 25th parallel; locally migratory.

Kagu (*Rhinochætus jubatus*).

Range. New Caledonia.

Sun-Bittern (*Eurypyga helias*).

Range. Northern countries of the Neotropical Region.
Food. Mostly insects.

REPTILIA

The Green Lizard (*Lacerta viridis*), from Central and Southern Europe; the Wall Lizard (*Lacerta muralis*), from Central and Southern Europe; the Filfola Wall Lizard (*L. muralis filfolensis*), from Filfola, near Malta; Dugès's Lizard (*Lacerta dugesii*), from Madeira; the Sand Lizard (*Lacerta agilis*), from North and Central Europe; and the Black-spotted Lizard (*Algiroides nigropunctatus*), from Dalmatia, feed mainly upon insects, worms, and small slugs.

Glass Snake (*Ophisaurus apus*).

South-eastern Europe. Feeds on small mammals, reptiles, slugs, etc.

Notes upon some of the above described Experiments by
Prof. E. B. Poulton, F.R.S., F.Z.S.

Pages 815–820.

The experiments on the *Pierinæ* support the conclusion that the perfection of the under surface procryptic resemblance affords a true criterion of the degree of palatability.

P. brassicæ, with its conspicuous gregarious larva, and imago larger and less cryptically coloured than the other three species

(although nearly the same as *P. rapæ* in this respect), was distinctly the least palatable of the four. On the other hand, *P. napi* and *E. cardamines*, in which the cryptic resemblance is carried to its highest pitch, appeared to be most palatable; but a larger number of experiments is greatly to be desired.

The results obtained in the two former species are of much interest in relation to the experiments upon *Melanargia galathea* (p. 827).

Pages 820–822.

The evidence that *V. urticæ* is not very palatable agrees with my own experiments * with a Marmoset; and I obtained the same results with *V. io* when offered in considerable numbers to lizards. It is probable that the procryptic under surface of the Vanessas is chiefly related to the attacks of mammals and of very hungry birds during the long hibernating period. The special interest in the eye-spots of *V. io* manifested by the Syrian Bulbul, accords with previous observations on other insects and other insect-eaters, Reptilian as well as Avian †.

Pages 823-825.

The evidence of a certain amount of unpalatability in *Brenthis* (Argynnidæ) is consistent with the degree of procryptic defence attained in this genus. It is also of much interest in connexion with the experiments on *Araschnia levana*, the early or *levana* form of which is probably a mimic of the species of *Brenthis*. The examples of the *Araschnia* tested by the author (pp. 823–824) were of the form *prorsa*, belonging to the later brood, and generally looked upon as mimics of the White Admiral (*Limenitis sibylla*), which appears upon the wing at about the same period. The experiments here recorded prove that the mimic is certainly unpalatable to several birds, and support the conclusion that the resemblance is Müllerian or Synaposematic. The evidence, so far as it goes, points indeed to the inference that *Araschnia* is more unpalatable than its *Brenthis* model. A few experiments on the imago of *L. sibylla* made by Mr. Pocock in the summer of 1910, also indicated that the *prorsa* form is more unpalatable than the *Limenitis*. There is, however, nothing improbable in a Müllerian mimic being more highly protected than its model. The rôle of model is related to many characteristics, and relative abundance, conspicuousness, and extent of range may play their part as well as relative unpalatability. Thus it is probable, from its habits and flight, that the Eastern European *Neptis lucilla*, W.V. (=*sappho* Pall.) is more distasteful than its *Limenitis* models, but the latter are widespread and abundant species, and it is reasonable to suppose that the memories of European insect-eating animals are more deeply impressed by their pattern than by that of the *Neptis*.

* Trans. Ent. Soc. Lond. 1902, p. 442.

† 'Essays on Evolution' (Poulton), 1908, p. 210: see also p. 326.

Pages 825–827.

The desirability of experiments upon the palatability of the genus *Melitæa* was suggested by the study in 1908 of a collection of butterflies from the Tian Shan or Celestial Mountains in Western Mongolia. Small as it was, the collection was sufficient to show that *Melitæa* is a dominant element in the insect fauna of the locality. The large "Skipper," *Hesperia antonia* Spey, was also abundantly represented, and I was at once struck with the marked resemblance which its under surface would bear in the position of rest to that of the species of *Melitæa*. The striking feature of the latter genus is supplied by two black-bordered orange bands which cross the hind wings and stand out conspicuously against the cream ground-colour. These two bands, the outer with its festooned, the inner with its irregular borders, present a highly characteristic appearance. The small portion of the fore wing under surface exposed in the position of rest conforms, as is usual in butterflies, to the pattern of the hind and appears as a slight extension of its area. In spite of differences in detail, the two orange bands of the Hesperid closely resemble those of *Melitæa*, and in all essential respects the exposed under surface of the former reproduces that of the latter. In the Skipper the outer margin of the outer band is cut into internervular concavities, while the inner bulges into corresponding convexities: in the Nymphaline, concavities are seen along both borders. The orange of the bands and the tint of the ground-colour—white between the bands, greyish elsewhere—are also much paler in the Skipper, but the orange pigment is probably quite different from that of *Melitæa* and may rapidly fade. It is also interesting to note that the orange bands of the under surface are represented by black bands on the upper surface of the Skipper but by orange bands on that of the Nymphaline. The allied *Hesperia sidæ* Esp., with golden bands, is doubtless a co-mimic with *H. antonia*, while in a third closely related species, *H. carthami* Hübn., the dark bands have gained a bronzy greenish or yellowish tinge, probably indicating the kind of variation out of which the pattern of the two first-named species was produced by selection.

Probable evidence that *Melitæa* is a specially protected genus is supplied by the well-known habits of the three British species *aurinia* (=*artemis*) Rott., *cinxia* L., and *athalia* Rott. All are known to be gregarious in the larval state, and so abundant in confined localities that they may be described as gregarious in the perfect state also. All are slow-flying and conspicuous on the wing and at rest between the flights, while individuals have been observed to "sham death" when captured. Putting all the facts together, it appeared probable that we have an interesting addition to the list of mimics among the Palæarctic butterflies, a list which is remarkably short in the western section of the Region. Mr. Pocock kindly consented to test the hypothesis that *Melitæa* possesses the distasteful qualities of a model for mimicry, and Commander J. J. Walker kindly helped to obtain material for

the experiments which are recorded on pp. 825–827. The results as a whole leave little doubt that *Melitæa* is distasteful to many birds, and that it does actually possess the qualities which would render it an advantageous model for the Hesperiidæ.

Pages 827–830.

The experiments on *Melanargia galathea* are of peculiar interest. The northern belt Satyrinæ of this genus, with their white ground-colour, stand out from the rest of their group. The under surfaces are conspicuous, the species slow-flying and so abundant locally that they may be called gregarious. The observations here recorded show that they are also distinguished by their greater distastefulness from other common northern Satyrines. The appearance of the species of *Melanargia*, especially on the wing, is markedly Pierine-like, and it is here also probable that a highly distasteful genus has mimicked an assemblage of species which, although generally less unpalatable, are excessively widespread and abundant in individuals (see also p. 865).

Pages 830–831.

The experiments upon Lycænidæ, Nemeobiinæ, and Hesperiidæ were not sufficiently numerous to form the foundation for safe conclusions.

Pages 831–855.

The remaining experiments, for the most part, afford valuable confirmation of previous work, but they also raise new questions of great interest. Confirmation is afforded by the evident unpalatability of *Zygæna*, *Euchelia*, and *Abraxas* among the moths, of the Saw-fly larvæ, of the Telephoridæ, Phytophaga, and Coccinellidæ among the beetles, and of the Hemiptera, as also by the special and peculiar defensive secretions of the Carabidæ and, in sharp contrast to all these observations, by the palatability of the procryptically coloured moths and larvæ.

Pages 847–848.

The apparent distastefulness of the humble-bee-like *Volucella bombylans* suggests conclusions of so much importance and interest that abundant confirmation is essential, and should be readily available with so common a species.

Pages 848–852.

Experimental evidence that the Aculeate Hymenoptera possess some special defence independently of the stings of the females is now obtained for the first time. It was suggested as probable by the present writer in 1904, as a result of the observation that the males of the bee *Sphecodes* emerge in immense numbers and form complex mimetic associations, before the appearance of the females, as also from the consideration that the Braconidæ are extensively mimicked *.

* Trans. Ent. Soc. Lond. 1904, pp. 645–6.

Page 849.

Although so many insectivorous animals in confinement disregarded the special defence of *Formica rufa*, there can be little doubt that such defence is very effective in the wild state. It is impossible on any other hypothesis to account for the conditions under which the species exists—swarming in vast numbers in restricted areas and an easy prey to any enemy that would dare to attack.

A very important conclusion is suggested by several of the experiments recorded in this memoir, namely, that the tastes of mammals and birds are widely different. The author points out that the defence of the ground-beetles appealed more strongly to the mammals than to the birds, but it was also apparent in many of the experiments that the unpalatability of conspicuous Lepidoptera was, conversely, far more obvious to the birds than to the mammals. In view of the part which birds are believed to play in the production of mimetic resemblance, it is obvious that this inference may be highly significant.

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From BEDROCK, No. 1, *April,* 1912, *pp.* 48—65.

DARWIN AND BERGSON ON THE INTERPRETATION OF EVOLUTION.

By E. B. Poulton.

The idea of an evolution driven onward from within, little affected or not affected at all by natural selection, has risen and declined again and again during the past half-century. But never before has the hypothesis of a creative "internal developmental force" been brought forward in so arresting a form as in the writings of Bergson. Here, in an argument adorned with literary charm, wide knowledge, profound and original thought, the distinguished author develops the conception of a primæval impulse, started with life itself, gathering impetus in its onward rush, dividing and expressing itself in the unceasing creation of endlessly varied forms.

In attempting to compare, within the necessary limits of an article, Bergson's conception of evolution with that of Darwin and Wallace, it appeared that the wisest course would be to restrict the discussion to certain definite problems. I propose, therefore, to confine myself to the *nature of instinct* and the *growth of a mimetic resemblance* —two problems on which much light has been thrown by recent research. Both problems are of high importance, and if, as I hope to show, in both the Bergsonian solution breaks down before the Darwinian, it is exceedingly improbable that there will be any other result when the same rival hypotheses are pitted against each other in any part of the field of evolution. The Darwinian looks upon instinct as an action performed under the compulsion of the nervous system. It depends, as Lloyd Morgan states, on the manner in which the nervous system is built through heredity. This system is so built in all animals that certain actions must follow certain stimuli. Instincts are of this class, and they have been gradually

improved and elaborated by the selection of individuals with nervous systems which compelled them to perform actions that were more and more helpful in the struggle for life.

Bergson, in his interpretation of instinct as "sympathy," relies much on the well-known, wonderful procedure of the *Ammophila*, a "Fossorial wasp," or "sand-wasp," which is believed to paralyse its caterpillar prey by stinging the nerve-ganglia of the ventral chain. Naturalists generally, following Fabre, have believed that caterpillars thus treated will "keep" and serve as food for the grub that presently hatches from the *Ammophila's* egg, and will at the same time be unable to do any harm by vigorous movements. Much has been written about the instinct itself, and the wonderful anatomical knowledge supposed to be possessed by the parent wasp. But there has been great exaggeration. Thus Dr. and Mrs. Peckham wrote after a careful study of these instincts in the American species :—

> "The general impression that remains with us . . . is that their complexity and perfection have been greatly over-estimated. We have found them in all stages of development and are convinced that they have passed through many degrees, from the simple to the complex, by the action of natural selection. Indeed, we find in them beautiful examples of the survival of the fittest." *

It is even doubtful, as it seems to the present writer, whether the *Ammophila* does, in fact, possess the exact knowledge that has been assumed.

The nervous ganglion of a caterpillar is a minute object, and it would be extremely difficult to prove that the sting had entered it. It might, perhaps, be shown by microscopic sections, or by finding the puncture in the skin and studying its exact relation to the underlying parts. So far as I am aware, no such convincing test has been applied, and it is probable that the recorded observations merely show that the poison is effective if injected by the sting anywhere in the neighbourhood of the nervous centres. This interpretation is supported by what we know of the methods of Fossorial wasps allied to *Ammophila* in their attacks upon huge spiders. Here the first sting is given in the rough-and-tumble of a terrific fight, when it would appear to be impossible for the wasp to puncture any organ

* *Instincts and Habits of Solitary Wasps*, Madison, Wis., 1898.

with precision; yet observers agree that the effect of that first sting is instantaneous, and enables the wasp without difficulty to disable its victim by further stings.

In the next place, whatever be the minute anatomical accuracy of the *Ammophila's* instincts, Bergson's hypothetical interpretation, although attractive and poetic, is very unconvincing, and could hardly have been propounded by the distinguished author if he had studied insects as a whole. According to Bergson, the instinctive actions of the *Ammophila* are the outcome of "sympathy," of its intimate closeness to life, and especially to the life of its victim.

> "We suppose a *sympathy* (in the etymological sense of the word) between the Ammophila and its victim, which teaches it from within, so to say, concerning the vulnerability of the caterpillar. This feeling of vulnerability might owe nothing to outward perception, but result from the mere presence together of the Ammophila and the caterpillar, considered no longer as two organisms, but as two activities." *

A wider consideration of the work of Fabre, the great naturalist on whom Bergson has relied, would have shown how improbable is such an interpretation. Thus Fabre has observed that *Bembex*—another Fossorial wasp, which does not store up food for the future, but feeds its larvæ from time to time with flies—is impelled to carry on its maternal duties by no inherent "sympathy" with its young, but in blind obedience to a stimulus in which the mouth of its burrow plays an essential part. For when Fabre dug the burrow away so that the larvæ of the *Bembex* were exposed to view, the mother was utterly puzzled and ceased to feed them. Her children were nothing to her when the front door was removed and the roof had been carried away! Even in birds the maternal instinct seems to be a blind impulse with nothing of the quality assumed by Bergson; and only because it is blind and mechanical has the evolution of the instinct of the cuckoo been rendered possible. Speaking of the neglect by a robin of her nestling turned out by a young cuckoo, F. B. Kirkman writes:—

> "It seems that if her nestlings are not where the mother expects them to be—in the nest—then for her they cease to exist. I have myself . . . placed a callow willow-wren on the ground an inch or two from the entrance of its nest, and though it wriggled

* *Creative Evolution*, p. 183, London, 1911.

there uncomfortably and conspicuously, the parent bird passed again and again over its head carrying food to the other nestlings without paying it the least attention." *

But there are other and even more serious objections to Bergson's views on instinct. It is by a limited outlook, by concentrating attention on the instinctive powers which are actively employed in attacking or repelling other animals, that men have been led to uphold a Lamarckian interpretation of instinct as "lapsed intelligence," and that Bergson, while repudiating this fallacy, is led to explain instinct as intuitive insight into life. The Lamarckian and Bergsonian hypotheses alike break down before a more extended survey. By far the commonest manifestations of protective instinct in insects are, when successful, sundered from all experience of other living forms. The "mere presence together" spoken of by Bergson (p. 50) is here non-existent. This argument was advanced by the present writer in 1887, as well as on later occasions, and, so far as he is aware, it has never been met. I may quote a paragraph published in 1905 :—

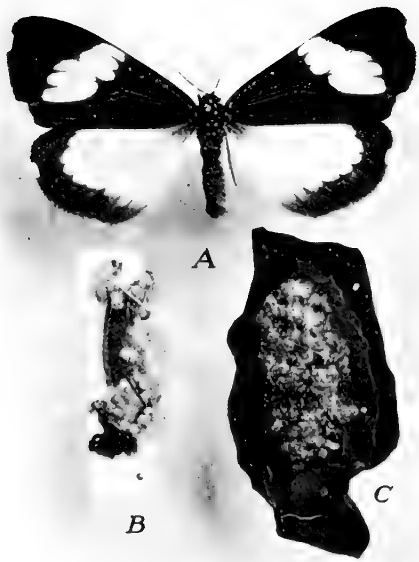
"It is not from the insects which have had the most varied experience of enemies, most opportunities of learning by contact with danger how to avoid them, and thus of developing their nervous systems through use—it is not from these that existing forms have been descended, but from precisely those which have had the least experience. Even for ourselves experience is spoken of as 'the stern guide.' To an insect she is apt to be so stern as to lose all her educational value. The less an insect sees of her the better the chance of existence and of representation in the generations of the future. The prime necessity for an insect, as for all animals which cannot in any real sense contend with their foes, is to avoid experience of them altogether." †

We may consider briefly a special kind of protective instinct, that of cocoon-making,—the preparation

"for the dangers of a struggle at some future time, when the organism which manifested the instinct will have changed its form, and become incapable of making further changes in the means of protection, and indeed as a rule entirely incapable of making any defence. . . . The Lamarckian interpretation fails to account for the cocoon-making instinct for two very sufficient

* *The British Bird Book*, Sect. VI., Vol. II., Ed. F. B. Kirkman, pp. 483—4, London and Edinburgh.

† *Essays on Evolution*, Poulton, Oxford, 1908, p. 155.



Natural size.

A. The day-flying moth (*Hypsidae*). *Deilemera antinorii*, bred from cocoon *C*, Oni, near Lagos. W. A. Lamborn.

B and *C*. Two cocoons of this species, showing the spheres passed by the caterpillar; then arranged and fixed in position so that they look like the heaped up small cocoons of a Braconid parasite. The back of the chrysalis of the *Deilemera* is seen beneath the heap on the left side of *B*.

[*To face* p. 52.

reasons: first, a chrysalis is incapable of learning by experience how to improve anything—even more obviously incapable of learning concerning a structure which it never makes. Secondly, however intelligent a chrysalis may be, the experience is of such a nature that its stores of learning cannot be handed down to posterity." *

The whole of this argument is equally destructive of Bergson's hypothesis. How can an unconscious insight into life confer on an insect the gift of prophecy and enable it to prepare in advance against the attacks of enemies it will never see—enemies that were never met by any of its ancestors? For the chrysalis detected by one of its natural foes is at once deprived of the possibility of becoming an ancestor.

No reasonable interpretation of these facts has ever been offered except the natural selection of Darwin and Wallace. In the light of this hypothesis we cannot but regard " these beautifully adapted structures as the outcome of countless generations during which the attacks of enemies have been, on the whole, more successful against the products of less perfected instincts and less so against those of the more perfected." †

It may be urged that the instinct of cocoon-making is not so remarkable or so difficult to explain as that which impels the *Ammophila* to sting its prey. It is very doubtful whether this contention is sound. Certainly the cocoon-making instinct is the more fixed and complete; for Dr. and Mrs. Peckham have shown that there is great variability and uncertainty in the methods of the *Ammophila* and in the effects produced on its victim.

It may be of interest to show by an example the elaborate complexity of which the cocoon-making instinct is capable. I select the cocoon (B, C) of the day-flying West African moth (*Deilemera antinorii*) (A), recently investigated by Mr. W. A. Lamborn in the Lagos district. The cocoon itself is slight and in large part concealed by a heaped-up mass of yellowish spheres fixed to the outermost layers of silk. When Mr. Lamborn first saw the two cocoons shown at B and C he quite believed that his caterpillars had been parasitised, and was greatly surprised when the moth (A) emerged from one of them (C). Even then he watched the cocoon for a long time, half expecting that some minute insect would emerge from the small

* *L. c.*, pp. 157, 159.   † *L. c.*, p. 160.

yellow bodies. Mr. G. F. Leigh, who made the same observation on the corresponding eastern species, at Durban, threw away his first cocoons in the full belief that they were parasitised.

The characteristic appearance of the abundant "Large Garden White" caterpillar when killed by a minute Braconid parasite must be familiar to many who are not entomologists. The shrivelled body of the victim—commonly found on fences or walls in the autumn—is covered and more or less completely concealed by a mass of little oval yellow cocoons spun by the Bracon larvæ immediately after their emergence from the caterpillar. The arrangement of the spheres by the African caterpillar is extremely like that of the Bracon cocoons—not only in the loosely heaped mass, but also in the outlying single spheres and groups of two or three. The difference in shape—spherical instead of oval—does not destroy the general impression of strong likeness, although a close examination at once shows that the spheres are composed of a hardened froth.

What is the advantage of this deceptive appearance of death from the attacks of parasites? It is not to protect against the parasites themselves; for the appearance suggests the effect of eggs laid in the body of the caterpillar at a very different and much earlier stage. It is probable that the protection is against insect-eating vertebrate enemies, ready enough to attack a caterpillar or chrysalis of a moth, but not tempted by a heap of tough cocoons each enclosing a small fraction of the nutriment contained in the caterpillar. For this reason probably the yellow or white cocoons of Bracons are such conspicuous objects.

The instinctive actions by which this deceptive appearance is produced are remarkable and elaborate. Mr. Lamborn has observed that while the silken walls of the cocoon are being built the caterpillar pauses every now and then and expels a sphere from the posterior extremity of the body. After a little heap has collected, it bends round, encircles a sphere with a few turns of silk, probably to serve as a handle, and then drags it off, arranges it on the growing mass, and fixes it in place with a few more threads. It would be unreasonable to suggest that this elaborate adaptation sprang into being by some ready-made "mutation." The uniformity, size, shape, and colour of the secreted spheres, and their arrangement by means of the appropriate instinctive actions, all contribute to the

effect, and such an origin by "mutation" implies that all arose in their present form and together. It is far more probable that this protective device was developed gradually from some excretion that had to be got rid of, and was utilised in the wall of the cocoon, rendering it opaque, dense, or unpalatable, like the crystals of arragonite that form a yellow powder in the cocoon of the "Lackey moth," or of oxalate of lime that confer hardness and density on the cocoon of the "Small Eggar moth." It has grown up and matured in a long succession of individuals that have never been in contact with the lives of enemies. The far larger number that in each generation were met by their foes have contributed nothing to this evolutionary history; for they have left no descendants. What is there in this past history to bring the instinctive "sympathy" or "insight" into relation with possible enemies rather than with species that do not attack the *Deilemera?* In this and in all the countless examples of the kind, the fact that the right enemies are prepared for beforehand in the right way cannot be explained by Bergson's hypothesis of instinct, nor by any other hypothesis as yet propounded except the Natural Selection of Darwin and Wallace.

Before passing to the consideration of my second subject—the origin and growth of a mimetic resemblance—it is necessary to attempt a brief discussion of Mimicry itself.

Superficial resemblances of several kinds are to be found between the forms of life inhabiting the same part of the earth's surface. Thus a wonderful "protective resemblance" to plants is borne by well-nigh innumerable insects, and many species of these, by their likeness to the same vegetable form, such as lichen or bark, gain incidentally a likeness to one another. That particular kind of superficial resemblance known as Mimicry is not an incidental, but a direct likeness borne by one animal, called the Mimic, to another known as the Model. However close the likeness between two forms may be, it is rarely difficult to decide between the Model, which preserves its relationship with the patterns of allied species, and the Mimic, which, in approaching the Model, has departed from the appearance of its group. Indeed, in a high proportion, perhaps in half of the mimetic species of butterflies, Mimicry is restricted to the female, while the male bears the ancestral pattern of the group to which the species belongs.

Several attempts have been made to explain the resemblance of Mimic to Model, but of these it is only necessary to mention four.

(1) Almost exactly half a century ago H. W. Bates, in his celebrated hypothesis, suggested that the abundant Models were specially protected by an unpleasant taste or in other ways, and that the palatable defenceless Mimics were mistaken for them, not only on account of their deceptive likeness, but also because they were so rare as to be lost in the swarms of an excessively common species. This hypothesis has been so completely popularised in text-books, articles and lectures, that, until recently, little attention has been paid to any other.

(2) Another great naturalist, Fritz Müller, also drawing his experience from the South American tropics, could only accept Bates' interpretation for a very few of the Mimics with which he was acquainted. The majority of these were abundant flourishing species belonging to groups which were evidently themselves specially protected and mimicked by species of other groups. Bates, too, knew of these highly successful Mimics, and recognising that they could not be explained by his hypothesis, believed that they were due to climate or some other influence connected with locality. Fritz Müller puzzled over these cases for many years and at first thought of an explanation based on Sexual Selection. It occurred to him as possible that the choice of mates might be influenced by the sight of the patterns of other species; and Darwin, to whom he gave a brief account of these views, was by no means disposed to regard them as extravagant or impossible. The real difficulty lies in the fact that selection is exercised by females rather than by males, while Mimicry, when restricted to a single sex, is, with hardly an exception, found in the female. There is, in fact, far more to be said in favour of the opposed hypothesis, that Sexual Selection accounts for the want of Mimicry in the males of so many mimetic females.

Finally, sixteen years after the publication of Bates' hypothesis, the interpretation of "Müllerian Mimicry" flashed across Fritz Müller's mind. His first brief sketch of the hypothesis, published in Carus' *Zoologischer Anzeiger* for 1878, has almost entirely escaped notice, eclipsed by the more complete account written for *Kosmos* (May, 1879), and at once translated by R. Meldola and

brought out in the *Proceedings of the Entomological Society of London* (1879, p. xx). The suddenness of the imaginative leap which produced the new hypothesis is made clear in the opening paragraph of the earlier paper, where Fritz Müller speaks of a problem over which one puzzles and puzzles, while the solution is all the time lying close at hand and obvious.

The Müllerian hypothesis is briefly as follows. Insect-eating animals do not come into the world with an instinctive knowledge of specially protected insects, and it is only by experiment that they gain a knowledge of the patterns which advertise unpalatability or danger. Experimental tasting means injury or death to insects, and anything which facilitates the education of enemies reduces the destruction of insect-life. Now the resemblance between specially protected forms does tend to lessen the amount of experimental tasting. If A and B possess the same pattern, an enemy, having tasted A, may not require to taste B at all, or may approach it more cautiously and do little injury. Another enemy will taste B first and then the dangers of experiment will be reduced for A.

Such, in few words, is the Müllerian hypothesis, and on the present occasion, I can say no more about it except to point out that much support is afforded by recent investigations showing that extraordinary intricacy is a common feature of mimetic combinations. The conclusions, originally stated by Fritz Müller, and in later years arrived at independently by F. A. Dixey, that mimetic resemblance may often be attained by reciprocal approach, is a matter of controversy, but there can be no dispute over the statement that mimetic species are often themselves the Models for mimicry.

(3) The third place is given to the hypothesis by which Bates sought to explain the resemblance between specially protected species as the result of climate or of food, the effect at any rate of one or more of the physico-chemical influences at work in the locality. This explanation may be called the hypotheses of External Forces. I formerly spoke of it as the hypothesis of "External Causes," but the Batesian and Müllerian hypotheses also depend upon external causes. The word "Force," on the other hand, points more directly to physico-chemical influences than to the selective elimination brought about by enemies.

A. R. Wallace at first, but not later, followed Bates in both

hypotheses, the first and the third, but Fritz Müller never could accept any explanation of Mimicry based on External Forces, and he proved* in answer to a paper by Wallace† that physico-chemical influences did not adequately explain the detail of mimetic resemblance.

(4) The last suggested explanation of Mimicry with which I propose to deal may be called the hypothesis of Internal Forces, formerly "Internal Causes." This interpretation is based on the supposition of an "internal creative force," upon the idea that progressive change is produced by forces resident within the organism itself—in fact, upon that conception of evolution of which Bergson's works supply the latest as well as the most distinguished exposition. According to this hypothesis, "Creative Evolution" has made both Model and Mimic, and has made them so that they are alike in the characters that can be seen, but in no other respect.

It now remains to test these hypotheses by the detailed consideration of a single example in which it is possible to make out the origin and history of the resemblance with a high degree of probability. In the selected example, which has only recently been fully worked out and understood, the ancestral pattern is still borne by the non-mimetic male, and we can judge of the changes that have been necessary in order to produce the mimetic female pattern. The example will, I venture to hope, furnish not only solid evidence of the fact of evolution, but also a clear indication of its causes. These results we owe to the combined study of Mimicry and geographical distribution by keen and enthusiastic naturalists in the tropics—men who are observing, collecting, breeding, and all the time keeping in close touch with a museum at home, where the material can be worked out and co-ordinated, and whence suggestions for fresh enquiries can be continually sent. It will be seen that I have been extraordinarily fortunate in the colleagues with whom the study has been pursued; and this is not only true of the localities under consideration, but of many other localities also, some African, some in other parts of the world.

The left-hand column of butterflies (Figs. 1—4) represents

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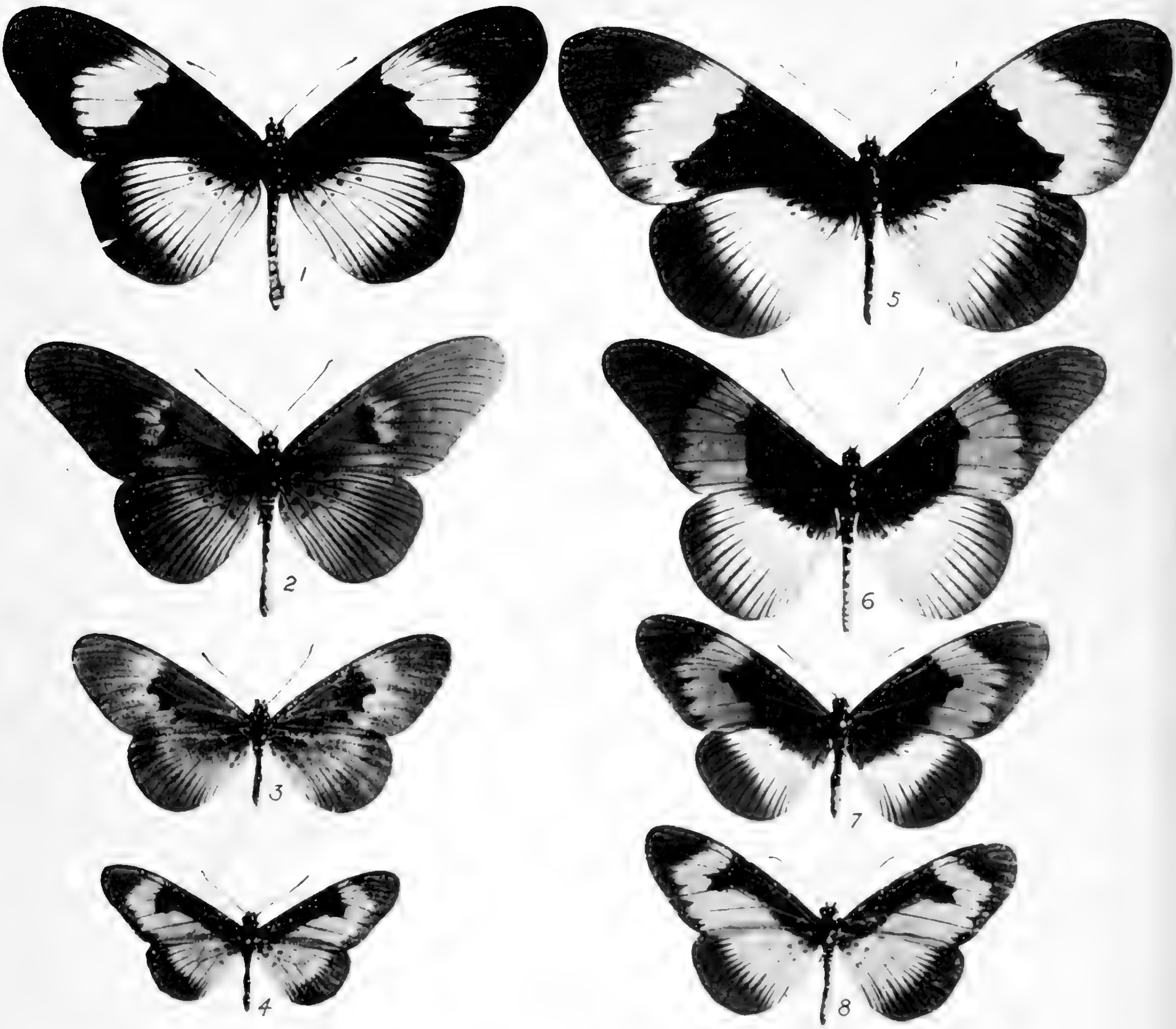
* *Kosmos*, x., Oct., 1881—Mar., 1882, pp. 157—167.

† Presidential Address to Sect. D., Brit. Assoc., Glasgow, 1876: reprinted in *Tropical Nature*, 1878, p. 256.

West.
Lagos District.

East.
Entebbe.



(1) Female *Planema alcinoe.*
(2) Male *Planema alcinoe.*
(3) Female *Acraea alciope* (mimic of the above male).
(4) Male *Acraea alciope* (non-mimetic).

(5) Female *Planema macarista.*
(6) Male *Planema macarista.*
(7) Female *Acraea alciope* (mimic of the above male).
(8) Male *Acraea alciope* (non-mimetic).

The figures are of the natural size.

(1) and (2) Captured February 14th and April 21st, 1910, a little above sea-level, near Oni camp, 70 miles east of Lagos. W. A. Lamborn.

(3) and (4) Bred December 18th and December 22nd, 1910, from a batch of eggs on one leaf, near Oni. W. A. Lamborn.

(5) and (6) Both captured August 14th, 1909, about 4,000 feet, on slopes of Kitabi Hill, about 2 miles north-east of Entebbe. C. A. Wiggins.

(7) and (8) Bred 1911 from a company of caterpillars found on one leaf, Damba Island, in the Victoria Nyanza, about 20 miles south-east of Entebbe. G. D. H. Carpenter.

specimens from the tropical west coast of Africa, a little north of the Equator; the right-hand column (Figs. 5—8) a series from the neighbourhood of Entebbe, on the Equator, at the north-west corner of the Victoria Nyanza.

The upper surface of the wings of all these butterflies, as well as of those shown in Figs. 9—14, is of a dusky, almost a black, ground-colour, with a pattern of white, ochre (restricted to Figs. 4 and 8), fulvous, or partly white and partly fulvous. This latter tint, very common in butterflies, is somewhat difficult to describe. Abbott H. Thayer, the American artist-naturalist, meets the difficulty by calling it "cow-red." Perhaps "orange-brown" conveys a sufficiently correct idea of its deeper, "orange-ochre" of its paler shades. The dusky and white are so well reproduced that coloured figures would not give a much better idea of the appearance. The ochre, and the fulvous tints are clearly indicated by the depth of the shade, although here colour would, of course, be a great improvement.

Fig. 1 represents the female, Fig. 2 the male of *Planema alcinoe*, belonging to the distasteful, much-mimicked family of the *Acrœinæ*, and itself proved by Mr. W. A. Lamborn to be highly unpalatable to monkeys which devoured many other butterflies with avidity, and to an insectivorous lizard, *Agama colonorum*, common in the locality. Fig. 3 represents the female, and Fig. 4 the male of the common *Acrœa alciope*. The figures clearly indicate the fact that the female differs from the male in the substitution of fulvous for ochre, and in the form of the pattern. She is also distinguished by her greater size, but here the effect is exaggerated because the male is a dwarfed specimen. The result of these differences is that the female *Acrœa* (Fig. 3) is an excellent Mimic of the male *Planema alcinoe* (Fig. 2), a butterfly larger than itself. There is little doubt that other fulvous-marked western *Planemæ* with patterns—in some species female as well as male—very similar to that of the male *alcinoe*, combine with this latter in supplying Models for the female *A. alciope*. But the details of the pattern, as well as the facts of geographical distribution, indicate that the male *Pl. alcinoe* is the principal Model. Although it is rather unusual in butterflies for a male to be mimicked by a female, the same exceptional relationship holds in the eastern part of the range of *alciope*, where another mimetic female mimics another male *Planema* (see p. 61).

In attempting to explain this example of Mimicry we may clear the ground by dismissing the hypothesis of Bates (1) and that of External Forces (3).

Acræa alciope belongs to another genus of the same distasteful sub-family as its Model. Mr. Lamborn has found by experiment that it is distasteful to the same insect-eating animals. Its non-mimetic male (Fig. 4) is furthermore mimicked by the female of *Mimacræa fulvaria*, one of the *Lycænidæ*—the family to which our British "Blues," "Coppers," and "Hairstreaks" belong. The probable male of *M. fulvaria* has been recognised by Mr. H. Eltringham in a large West African Lycænid which mimics the *Planema*-models of the female *alciope.* If this identification be confirmed, we have a good example of the tangled relationship so often found in Müllerian combinations. The female of *alciope*, and the male of *fulvaria* both mimic the same *Planemæ*, while the female of *fulvaria* mimics the non-mimetic male of *alciope.*

The Batesian hypothesis does not explain the resemblance of the distasteful female *Acræa* to a distasteful male *Planema.*

The fact that the physico-chemical forces of the locality have not brought about the mimetic resemblance of *alciope* is sufficiently shown by the fact that the non-mimetic male and the mimetic female are both developed from gregarious larvæ, living together under precisely similar conditions. The specimens represented in Figs. 3 and 4 are two out of a large company developed from the same batch of eggs found by Mr. Lamborn on a single leaf, and evidently laid by a single female. The larvæ hatched on November 21st, 1910, were fed on the same food-plant, and together with the pupæ were kept under uniform conditions. This was the twelfth in a series of companies of which each was raised in the same way by Mr. Lamborn from a batch of eggs, or from minute recently hatched larvæ found upon a single leaf. The males, which have not yet been counted, were all non-mimetic and similar to those found wild in the locality; the 249 females were all mimetic and, with a single exception (see p. 63), also similar to the wild forms of the Lagos district.

In attempting to account for the origin of these mimetic females we can only look, among existing hypotheses, to the growth of a Müllerian resemblance by the operation of Natural Selection (2), or

to a manifestation of " Creative Evolution "—the gradual or sudden expression of forces locked up within the organism (4). The fact of female Mimicry is of course a serious difficulty encountered by the last hypothesis, but any further discussion of these two rival interpretations is better postponed until after the consideration of *Acræa alciope* and its Models in Uganda, at the opposite or eastern side of their range.

Our detailed knowledge of these forms in the neighbourhood of Entebbe is almost entirely due to Mr. C. A. Wiggins, D.P.M.O., of the Uganda Protectorate. The constant pressure of official duties has prevented Mr. Wiggins from breeding the insects, but by employing natives to collect at short intervals, by collecting himself, whenever the opportunity offered, and, above all, by keeping the collections distinct and carefully labelled, he has thrown a flood of new light upon the numerical relations of Models and Mimics, at different seasons and in different years. A part of his results, including *A. alciope* and its Models, obtained between May 23rd and August 31st, 1909, was communicated to the first International Entomological Congress at Brussels, in August, 1910, and is published in the Report. During the past year Mr. Wiggins took the opportunity afforded by his leave to study the whole of the vast mass of material presented by him to the Hope Collection at Oxford. Working together we have tabulated and expect soon to publish an account of all the mimetic associations captured between August 31st, 1909, and February, 1911. The figures on the present occasion will be quoted from the Brussels paper, but it may be said that the more extended study in every way confirms the earlier conclusions as to the relationship between Model and Mimic.

Planema alcinoe, the western Model, also occurs at Entebbe, but it is unaccompanied by any of the western species with a fulvous-marked pattern similar to that of its male. It is not very common, thirty males and eleven females being taken in thirty days' collecting between May 23rd and August 31st, 1909. On the other hand, thirty-five males and fifty-two females of *Acræa alciope* were captured in thirty-four days between the same dates. It is therefore, not surprising to find that, in the eastern part of its range, the female *alciope* is no longer a Mimic of *Pl. alcinoe.* It may be of interest to those who believe in the paramount importance of climate,

to know that the pattern of *Pl. alcinoe*, taken at a height of 4,000 feet at Entebbe, is the same as that of the species at Mr. Lamborn's, locality seventy miles east of Lagos, a few feet above sea-level. The same is true of the male *A. alciope*, as may be seen by comparing Figs. 4 and 8.

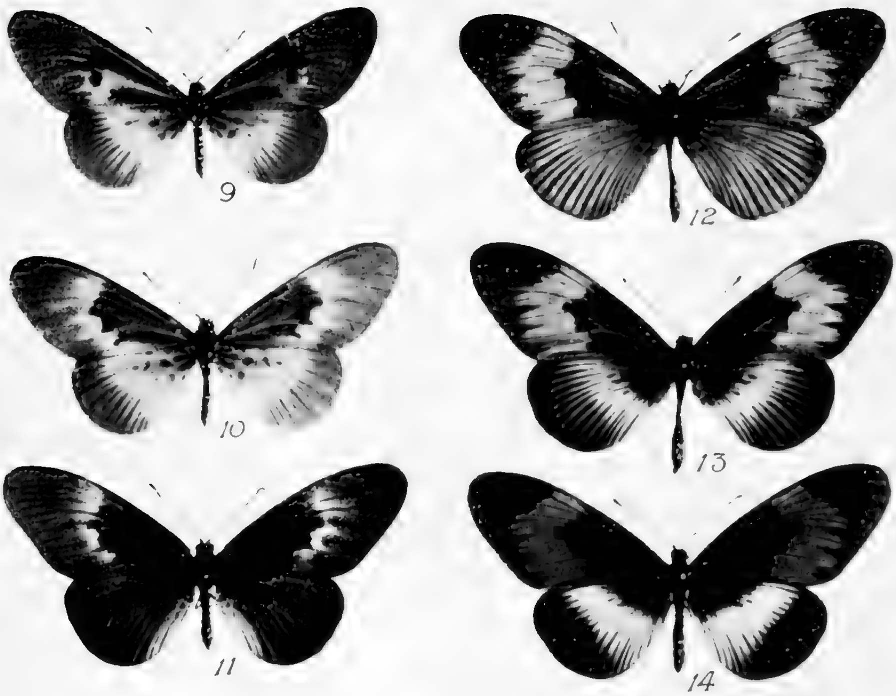
The Model of the female *alciope* at Entebbe (Fig. 7) is found in the male of a dominant species of *Planema*—*Pl. macarista* (Fig. 6), aided by both sexes of *Pl. poggei*.

The female of *Pl. macarista* (Fig. 5) bears a black-and-white pattern very like that of the female *alcinoe* (Fig. 1), but its male (Fig. 6), together with both sexes of *Pl. poggei*, exhibits the effective combination of a fulvous bar crossing the fore wing with a white bar crossing the hind. They are thus far more striking insects than the male of *Pl. alcinoe*. The dominance of this pattern is well shown in Mr. Wiggins' series ; for in the period already defined, eighty-one males of *macarista*, eleven males and one female of *poggei* were taken in thirty-four days, while thirty-nine females of *macarista* were captured in thirty days. It is clear, from the details of the colouring and pattern, and from its relative abundance, that the male *Pl. macarista* is the principal Model of the female *A. alciope*.

As regards the interpretation, the records in the eastern part of the range confirm those in the western. Fifty-two females of *alciope*, of which, however, three were without the white bar (Fig. 12), to eighty-one of the male *macarista*, is an immense proportion for a Mimic to bear to its Model, and even if we add the twelve *Pl. poggei*, and deduct the three *alciope* females, the ratio is still well over 52 per cent. Such a proportion, the average of thirty-four days spread over three months, and supported by unpublished records of a far longer period, is quite inconsistent with the Batesian hypothesis as propounded by its founder.

The female and male *alciope*, represented in Figs. 7 and 8 respectively, were part of a family of eight males and five females bred by Dr. G. D. H. Carpenter from thirteen small caterpillars found on a single leaf on Damba Island, near Entebbe ; and Dr. Carpenter has since raised other families in the same locality. The influence of food and climate as the explanation of Mimicry breaks down even more completely at Entebbe than at Lagos. The eastern female of *alciope* is, as will be shown, a recent modification of the western,

West.	East.
Lagos District.	Entebbe.



Western females of *Acraea alciope*. Eastern females of *Acraea alciope*.

The figures are of the natural size.

(9) and (10) Bred December 21st and 18th, 1910, from same batch of eggs, near Oni. W. A. Lamborn. (10) represents the same female as (3).

(11) Bred December 18th, 1910, probably from the above-mentioned batch of eggs. Out of 249 females bred at Oni this specimen is the only one with a well-marked white bar crossing the fore wing. It shows how a mimetic modification might arise if an appropriate model existed in the locality.

(12) Captured, with another like it, August 14th, 1909, Kitabi Hill. C. A. Wiggins. The specimen represents the ancestral form, much like the western female shown in (10), before the eastern mimicry had appeared.

(13) Captured, 1911, on Damba Island. G. D. H. Carpenter. The specimen shows an incipient white band, and probably resembles the variety from which the eastern mimetic female (14) arose.

(14) Bred Damba Island. The same specimen as that shown in (7).

[To face p. 62.

and we may safely infer that the male and female larvæ, gregarious in both east and west, were certainly gregarious, and therefore subject to uniform conditions, when the eastern form evolved.

The comparison of Fig. 7 with Fig. 3 shows that the eastern female of *alciope*, in correspondence with the change of Model, presents a very different appearance from the western; so much so, indeed, that it was for a long time looked upon as a distinct species, and doubtless still stands as a distinct species in many collections. It was described by Staudinger in 1896, and named by him "*aurivillii*," after the great Swedish naturalist, and it was only in 1909 that Mr. H. Eltringham, studying the Wiggins Collection at Oxford, and in consultation with Dr. Karl Jordan of Tring, identified the supposed new species as a female of the well-known and abundant *Acræa alciope*—a conclusion confirmed by Dr. Carpenter in 1911.

In attempting to understand the origin of the eastern Mimic, much help is afforded by the three exceptional females referred to on p. 61, and represented in Fig. 12. This form of female, without the white bar on the hind wing, was erroneously figured in 1901 as the *male* of "*alicia*"; for under this latter name "*aurivillii*" was redescribed in spite of Staudinger's publication five years before. The eastern females of *alciope* furnish good examples of the mistakes into which systematic naturalists have been led by Mimicry.

Two of these exceptional females were captured by Mr. Wiggins on August 14th, 1909, and one by his native collector on August 18th. Three females of the usual eastern form and one male were also taken on the earlier date, four females and two males on the later. A small proportion of these rare "*alicia*" forms is also found in the later captures, together with occasional intermediates similar to the specimen represented in Fig. 13, captured in 1911, by Dr. Carpenter, on Damba Island. There can be no doubt that these rare females represent the ancestral form which gave rise to the eastern mimetic females (Fig. 14). That they are of a western type may be seen by comparing Figs. 10 and 12; for the only essential difference between the two patterns is the breadth of the fulvous area on both wings. The amount of spotting on the hind wing upper surface is unessential, being extremely variable. It is a curious fact that intermediates

between the eastern and western females of *alciope* are found on the western island of Fernando Po. It is to be hoped that we shall soon be in possession of the same full and careful records of *Planema* Models and *Acræa* Mimics, from this part of the range and from the opposite coast of the Cameroons, that are now available from Lagos and Entebbe.

If the appearance of the white bar were sufficient to transform "*alicia*" (Fig. 12) into "*aurivillii*" (Fig. 14) it is not unlikely that a single sudden step might produce the change. But it is by no means sufficient. The uncoloured figures indicate, although they cannot show, that the fulvous markings of the fore wing in Fig. 12 gain a deeper tinge in Fig. 14, and that those of the hind wing are, outside the band, more or less replaced by the dusky ground-colour. Furthermore, the base of the hind wing under surface of "*aurivillii*" is marked with a warm umber triangle bearing the black spots which are found in this position in "*alicia*." Now all these points of difference between the butterflies represented in Figs. 12 and 14 are characteristic features of the Model—the male of *Planema macarista*.

If it be unreasonable to suppose that all these mimetic features arose spontaneously and together, what is the probable explanation of their origin? It is probable that by spontaneous variation a white band like that shown in Fig. 13 appeared in the ancestral form (Fig. 12), and that this was from the very first sufficient to confer some advantage by suggesting the appearance of a dominant Model (Fig. 6). From this point Natural Selection acting on further variations produced the detailed likeness which we see in the white band itself and in the other mimetic features.

If this be a valid interpretation, we ought, by studying sufficient material, to find variations corresponding to that shown in Fig. 13—variations which might form the starting-point of new mimetic patterns if suitable Models happened to exist in the locality. *We do find such variations*, and a good example occurred among the 249 *alciope* females bred by Mr. Lamborn. The fulvous bar crossing the fore wing was transformed into white in a single one of these (Fig. 11), and a slight indication of the same change was seen in a second specimen. Both individuals belonged to the same family.

Now if there existed in the locality a dominant *Planema* or other

unpalatable Model with a white bar crossing the fore wing, such a variety as that represented in Fig. 11 might well form the starting-point for a new mimetic form. If, in part of the range, such a model predominated over *Planemœ* of the type of the male *Pl. alcinoe* (Fig. 2) we should expect the new form more or less completely to supplant the ordinary western female (Figs. 9 and 10). No such Model exists in the Lagos district, and therefore the variety represented in Fig. 11 is at a disadvantage as compared with the ordinary females and is extremely unlikely to escape extinction.

The comparison between the eastern and western forms of a single mimetic *Acrœa*, therefore, leads to important conclusions. The essential cause of the detailed likeness of Mimicry is Natural Selection—" mechanism," as it is called by Bergson. We do not know how or why the first essential variation arose, nor do we know the origin of the later variations out of which the detailed mimetic pattern was built. We do not know, and therefore the " *élan vital,*" the " rush of life "—an origin that can only be disproved by finding an origin that is capable of proof—may be accepted by those to whom it appeals. The majority of scientific men will probably prefer to follow Darwin and rest content with an admission of ignorance. But when ignorance is replaced by the fullest knowledge the *rôle* of variation will remain the same ; it provides the rough stones out of which the finished building is erected by selection—to use a metaphor employed by Darwin in *Variation under Domestication.* Everything that excites our wonder and admiration in the close and detailed mimicry of the male of a very different species by the female of *alciope* has been built up out of small differences by the accumulative power of selection. Even the first essential variation which produced a rough likeness to the Model, is, as a variation, a very small affair,—a minute transformation, probably chemical in nature, which involved the change from fulvous to white over part of the hind wing. And this variation would have been of no more significance to the species than the western variety shown in Fig. 11 if the pattern of the male *Planema macarista* had not existed at Entebbe.

The beginnings of a mimetic resemblance between species that were originally very unlike has been a great difficulty to many naturalists, but I believe that the example discussed in the present

paper shows how the problem has been solved by Nature. Taking the same Uganda Model, *Planema macarista*, I might, by describing all its Mimics, have produced a far more vivid impression of what Mimicry can achieve. I might have emphasized the initial stage by dwelling on the least perfect Mimic, or the minute and detailed likeness of the final result by speaking of the most perfect. But for the purpose in hand it was better to choose a species in which a strong mimetic likeness has been produced, while at the same time the initial stage may still be found persisting in certain rare individuals. I have attempted to show that the mimetic female of *Acræa alciope* is an unexplained coincidence under Bergson's hypothesis, but receives a reasonable interpretation under Darwin's. Although but a single case, it is in all essential respects typical of mimetic resemblance in general; and the hypothesis that explains mimetic resemblance explains evolution.

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LETTER FROM PROFESSOR POULTON

THERE are many points which it would be interesting to discuss in Mr. Francis B. Sumner's review of my book, "Charles Darwin and the Origin of Species."[1] I should, however, have abstained from troubling you were it not for Mr. Sumner's quotation of Professor Punnett's extraordinary misstatement of the modern Darwinian view.[2] For some time I had been intending to correct this curious blunder, and now that it has been quoted in your pages and even gives an ill-founded relief to Mr. Sumner, I feel that the time has come.

Professor Punnett is speaking of two African species of the Danaine genus, *Amauris,* respectively mimicked by two Nymphaline butterflies found in the same localities. The two Danaines are *Amauris niavius dominicanus* and *Amauris echeria;* the two Nymphalines, *Euralia wahlbergi* and *Euralia mima.* All four are figured on Plate VI., facing page 134 of "Mendelism." Mr. G. A. K. Marshall, in 1902,[3] suggested that the two *Euralias* are probably forms of the same species, but the proof was not finally obtained until 1909 when the late Mr. A. D. Millar, of Durban, bred both forms from a single female.[4] There is good reason to believe, as Professor Punnett states,[5] that the relationship between the two forms is Mendelian, and I can now further add that there is no doubt that *mima* is dominant and *wahlbergi* recessive. This conclusion is founded on the recent experiments of my friend, Mr. W. A. Lamborn, on the corresponding forms in the Lagos district, viz., *dubia* (=*mima*) and *anthedon* (=*wahlbergi*). Details of these experiments were communicated a few weeks ago to the Entomological Society of London, and will appear in the *Proceedings* for the present year. Now for Professor Punnett's statement: "On the modern Darwinian view certain individuals of *A. dominicanus* gradually diverged from the *dominicanus* type and eventually reached the *echeria* type, though why this should have happened does not appear to be clear. At the same time those specimens [of *Euralia*] which tended to vary in the direction of *A. echeria* in places where this species was more abundant

[1] This Journal, Vol. IX., pages 159–161.

[2] "Mendelism," page 134. This, at least, is the reference in the third British edition, 1911, of Professor Punnett's work. The footnote on page 160 of The Journal of Philosophy gives page 144.

[3] *Trans. Ent. Soc. London,* pages 491–2.

[4] *Proc. Ent. Soc.,* London, 1910, pages xiv–xvi; *Trans.,* page 498.

[5] "Mendelism," page 135.

than *A. dominicanus,* were encouraged by natural selection, and under its guiding hand the form *mima* eventually arose from *wahlbergi.*

"According to Mendelian views, on the other hand, *A. echeria* arose suddenly from *A. dominicanus* (or *vice versa*), and similarly *mima* arose suddenly from *wahlbergi* (p. 134). . . . On this view the genera *Amauris* and *Euralia* contain a similar set of pattern factors, and the conditions, whatever they may be, which bring about mutation in the former lead to the production of a similar mutation in the latter" (p. 135).

Although Professor Punnett ought to be competent to express "Mendelian views," I am pretty confident that he will be unable to find a single Mendelian writer who would accept his assumption about the origin of the two species of *Amauris.* But, however this may be, it is quite certain that no Darwinian, modern or ancient, and certainly no student of insect systematics, has committed himself to the belief that one of these two Danaine models has directly arisen from the other.

The late Dr. F. Moore, in his revision of the *Danainæ,*[6] placed *echeria* and *dominicanus* in separate genera. In this he was probably wrong, but they are certainly widely separated. *Amauris niavius niavius* of the west, together with the eastern sub-species, *niavius dominicanus,* occupies an isolated position in the genus *Amauris,* and it is absurd—I can use no milder word—to suggest that *echeria* arose directly from either of them. Hence, the whole of Professor Punnett's assumption of a parallelism in origin between model and mimic, which Mr. Sumner finds so comforting, falls to the ground.

May I say in conclusion that, although the relationship between the two mimetic forms of *Euralia* is undoubtedly Mendelian, I can not believe that one of them arose suddenly from the other? I believe that any one who looks at Professor Punnett's Plate VI. will hesitate to accept the view that the details of either of the two mimetic patterns—reproducing with great precision the pattern of a species belonging to a different sub-family—arose all at once from the other by mutation.

I have, furthermore, some evidence in support of the conclusion that the origin of the mimicry was gradual. Another closely related species, *Euralia dinarcha,* presents on the west coast of Africa two forms very roughly resembling the Danaine models which are so won-

[6] *Proc. Zool. Soc. London,* 1883, page 201. Dr. Moore placed *echeria* and an allied species in *Nebroda.* Aurivillius in his great "Rhopalocera Æthiopica" places *niavius,* including the eastern form *dominicanus,* second and *echeria* fifteenth in the genus *Amauris.*

derfully mimicked by the forms *anthedon* and *dubia* of the allied species. I very much hope that Mr. Lamborn will be able to breed *E. dinarcha,* and ascertain whether the Mendelian relationship exists between its two forms.[7] But whether this is so or not, there can be little doubt that these forms exhibit to us an initial stage in an evolutionary journey which has been carried very much further by *anthedon* and *dubia.*

There are other interesting facts which remain to be further investigated in the Mendelian relationship of these mimics. Mr. Lamborn informs me that the recessive form *anthedon* shows a well-marked tendency to appear seasonally; so that, during part of the year, he finds only this form on the wing. Then, later on, *dubia* suddenly appears. Such a phenomenon is extremely difficult to explain on ordinary Mendelian lines. Either we are faced by some undiscovered aspect of Mendel's law or the dominant form must have the power of lying dormant in some one or more of its stages, and then suddenly appearing. Against this latter hypothesis is the fact that in the seven large families bred by Mr. Lamborn, and now in the Oxford University Museum, there was not the slightest evidence of any difference between the two forms in this respect.

EDWARD B. POULTON.

OXFORD UNIVERSITY MUSEUM.

[7] Returning to Oxford at the end of the Easter vacation, I find a letter from Mr. Lamborn written March 29, 1912, from Oni Camp, near Lagos, telling me that he has now succeeded in obtaining eggs from both forms of *E. dinarcha,* and that the larvæ are doing well. We may hope for evidence, which will decide whether these two forms are a Mendelian pair, in a few weeks. I am very fortunate in having friends in the tropics who are so often able to supply us with just the very solutions for which we are looking with the utmost interest and eagerness.—E. B. P.

From BEDROCK, Vol. II., No. 1, *April,* 1913, *pp.* 42—56.

MIMICRY, MUTATION AND MENDELISM

By Professor E. B. Poulton, F.R.S.

In the first number of Bedrock the origin and growth of a mimetic resemblance was considered in relation to the theories of Charles Darwin and Henri Bergson. I now propose to describe and illustrate further recent discoveries in the same subject, and to discuss their bearing upon the place of Mutation and of Mendelism in evolution. A brief account of the theories of mimicry was given in the article already referred to. On the present occasion it is only necessary to point out that, although the growth of a mimetic pattern on the wings of a butterfly is a very short and a very late chapter of evolutionary history, the record is, within its limits, remarkably complete. The mutationist believes that evolution proceeds discontinuously by large steps. A fully formed mimetic pattern may certainly strike the observer as a large step, but its significance is magnified by the nature of the appeal that is made to us by the sense of sight. Mutationists and Mendelians have sometimes shown a tendency to yield to this appeal, and to measure the evolutionary importance of a change by the depth of a subjective impression. No effect caused by the presence or absence or the distribution of certain superficial colours can be compared for importance with changes involving such systems as the nervous, muscular, and skeletal. If it were possible to prove that a mimetic pattern arose fully formed and complete by a sudden mutation, it would by no means follow that more deeply-seated changes have been brought about in the same way. If, on the other hand, it can be shown that a likeness was evolved by the progressive modification of a series of stages, strong grounds will be afforded for the belief that more fundamental changes were effected gradually and not suddenly.

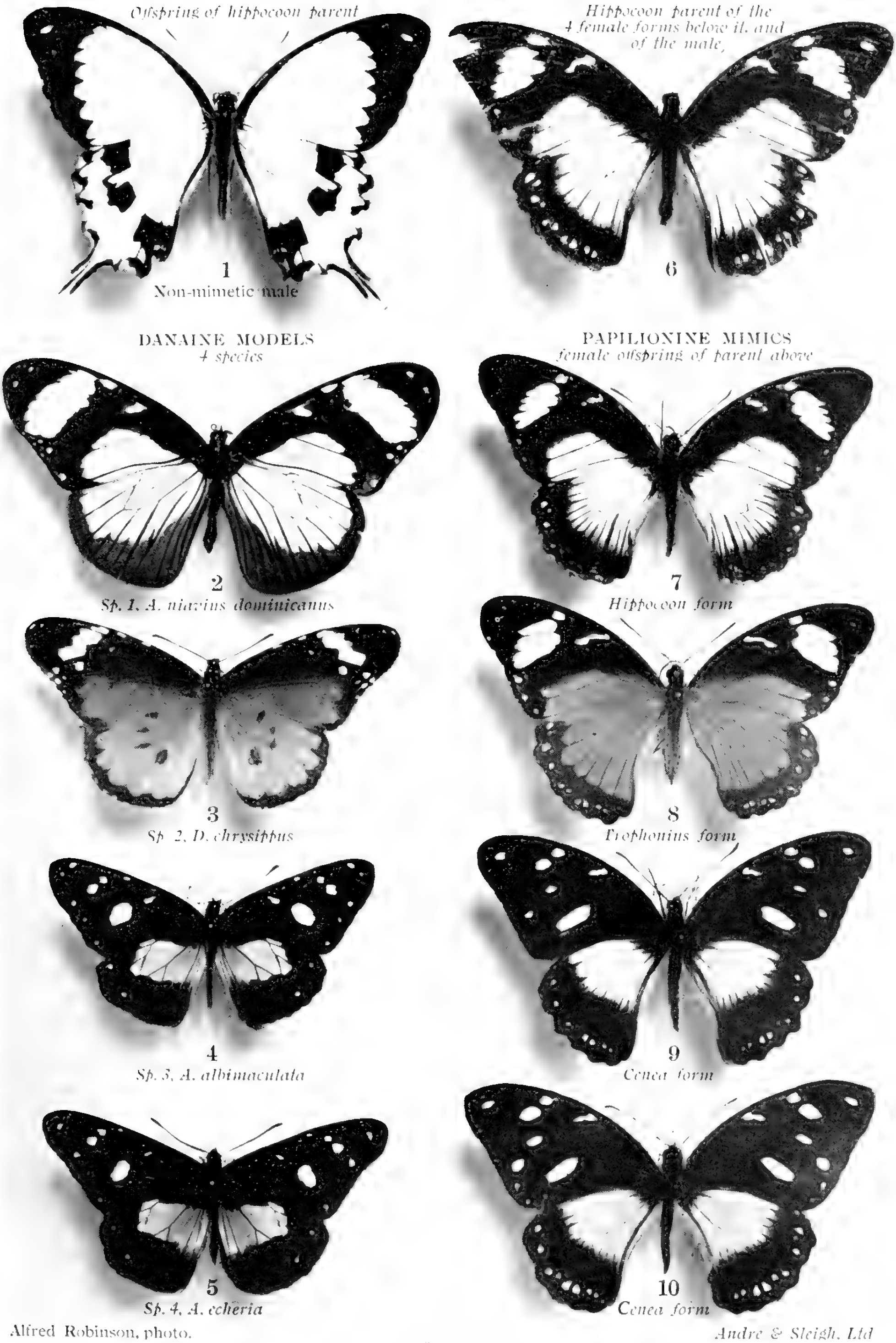
MIMICRY, MUTATION AND MENDELISM

I propose to consider two important examples of mimicry in African butterflies—examples on which much new light has been shed by recent researches. The models for mimicry belong, with a single exception, to the *Danainæ:* the exception is an Acræine. The *Danainæ* and *Acræinæ* have been shown by many experiments to be distasteful to insect-eating animals, and both are extensively mimicked in other parts of the world as well as in Africa.

First, *Papilio dardanus*, or, as it used to be called, *Papilio merope*. The train of mimetic females accompanying the non-mimetic male of this species and changing in relation to the models in various parts of Africa has often been spoken of as the most wonderful example of mimicry in the world. The splendid conclusions announced by Roland Trimen in 1868 are clearly shown in the accompanying Plate I. When Trimen began his enquiries the butterfly shown in Fig. 1 was known as *Papilio merope*, that in Figs. 6 and 7 as *P. hippocoon*, in Fig. 8 as *P. trophonius*, in Figs. 9 and 10 as *P. cenea.* All these were considered to be entirely distinct species. After studying all the material available in museums and private collections in Africa and Europe, Trimen found that *merope* was invariably a male and the other three invariably females. By a masterly analysis of the markings of the three female forms and their varieties he brought out the essential resemblance that underlay the superficial divergence; while, by comparison with the non-mimetic female of an allied species in Madagascar (Plate II., Figs. 1 and 2), he was able to suggest the origin of the female forms from a pattern closely similar to that of the male.

All this evidence was discussed in Trimen's great memoir in the *Transactions of the Linnean Society* for 1869 (Part III. of Vol. XXVI., p. 497), in which he established the conclusion that *hippocoon* (Fig. 7 on the accompanying Plate I.) is a female form of *merope* (Fig. 1) modified by mimicry of the conspicuous Danaine *Amauris dominicanus* (Fig. 2), that another female form, *trophonius* (Fig. 8), arose in mimicry of *Danaida chrysippus* (Fig. 3), and a third, *cenea* (Figs. 9 and 10), in mimicry of *Amauris echeria* (Fig. 5). These views at first met with opposition and even ridicule, but confirmation of various kinds rapidly accumulated, and Trimen's conclusions were generally accepted long before the final proof was obtained at Durban in 1902, when G. F. Leigh bred eighteen males (*merope*),

Plate I.



Alfred Robinson, photo. Andre & Sleigh, Ltd

Nearly ⅔ of the natural size.

Papilio dardanus cenea, the S. E. African Sub-species of *P. dardanus* with the four Danaine models of its female forms. The proof by breeding that the mimics are one species. (Near Durban, Natal, 1906, G. F. Leigh.)

twenty-four *cenea* females and three *hippocoon* females from the eggs laid by a female parent of the *cenea* form which he captured *in copulâ* with a male *merope*. The still more wonderful family illustrated on Plate I. was bred by him in 1906 from a *hippocoon* form of female (Fig. 6). Of the twenty-eight offspring reared from her eggs, fourteen were males (Fig. 1), three were *hippocoon* females (Fig. 7) like the parent, three were *trophonius* females (Fig. 8), three were *cenea* females with white spots in the fore wing (Fig. 9), and five were *cenea* females with one or more of the spots yellowish (Fig. 10). The Hope Collection at Oxford now possesses seven families, bred between 1902 and 1910 by Mr. Leigh, from females captured in the neighbourhood of Durban—twice from *cenea*, twice from *hippocoon*, and three times from *trophonius*. A very striking fact was the predominance of *cenea* in the offspring of all seven parents. One *hippocoon* and one *trophonius* produced nothing but *cenea*. The whole of the offspring added together give ninety-eight males, ninety-one *cenea* females, nine *hippocoon*, eight *trophonius*, and two of a new female form, *leighi*, both of which appeared in the last family bred in 1910 from a *trophonius* female. This remarkable family also contained twenty-five males, twenty-two *cenea* females, two *hippocoon*, and four *trophonius*. I know of only a single Natal family of *P. dardanus* in which *cenea* is not the dominant female form—a brood, reared by Miss Fountaine from the eggs of *trophonius*, with nineteen females of the same form as the parent and two of the *cenea* form. Specimens strictly intermediate between the female forms have not occurred in any family that I have seen, but slight indications of transition between *cenea* and the other females are not uncommon. The parental form may apparently exert an influence on the colour of offspring belonging to a different form. Thus the hind wing patch of some of the *cenea* offspring is apt to be deeper in tint when the female parent was *trophonius* with its rich fulvous markings, than when they have been bred from the white-marked *hippocoon*.

The facts summarised above are consistent with, and indeed strongly suggest, a Mendelian interpretation of the hereditary relationships, but the complete and detailed proof would be very difficult to obtain because of the unknown tendencies borne by the male. This difficulty could probably be overcome by bringing eggs,

larvæ or pupæ from Gazaland in south-east Rhodesia and pairing the resulting males with Natal females. The *hippocoon* form is far more dominant in the former locality than *cenea* in Natal, and it may be safely assumed that the vast majority of the males would bear the tendencies of *hippocoon* alone. If the proportions of the female forms observed in any locality are reflected with tolerable accuracy in the families reared from females of that locality—and this is certainly true in Natal and in the Lagos district of West Africa—we may feel confident that nine out of ten *hippocoon* females from Chirinda in south-east Rhodesia would yield *hippocoon* females and no others. The experiment has not yet been attempted at Chirinda, but it has been tried in the Lagos district, where the western form of *hippocoon* is at least equally dominant. I here predicted that no females but *hippocoon* would be bred from the great majority of parents of this form. My kind friend, Mr. W. A. Lamborn, has now bred six families for me. The female offspring of all six are without exception *hippocoon*.

The explanation of the relative proportions of the female forms in different parts of Africa is to be found in the prevalent local Danaine butterflies and in the presence or absence of a single Acræine. In Natal, the two species of *Amauris* (Figs. 4 and 5 on Plate I.) are by far the most abundant Danaines, while *A. dominicanus* (Fig. 2) is generally rare, and often not to be seen at all. *D. chrysippus* (Fig. 3) is always common, but it frequents the more open woodland spaces, while *P. dardanus* prefers the dense forest; and model and mimic only mingle freely where the two types of country pass into each other. Probably on this account the *trophonius* form, although occurring wherever *dardanus* exists in Africa, is always relatively rare, while its ubiquitous model is common throughout the Ethiopian Region. As we pass westward into Cape Colony the proportions of the female forms remain much the same, except that *hippocoon* is even rarer than in Natal, while its model, *A. dominicanus*, is altogether unknown. Passing northward along the east coast, the striking feature is the rapid increase and predominance of *hippocoon* and the relative rarity of *cenea* as well as *trophonius*. This change corresponds with the rise in importance of *A. dominicanus*. Even where *echeria* and its ally are far more abundant than *dominicanus*, if the latter be at all common, *hippocoon* will be abundant and *cenea*

rare among the female forms of *dardanus*. The explanation is almost certainly to be found in the conspicuous black-and-white pattern which makes *dominicanus* one of the most striking and easily remembered of all African butterflies. The comparison of Fig. 2 with 4 and 5, will at once suggest that *dominicanus* forms a far more striking feature in a forest than a much larger number of *echeria* and *albimaculata*.

With probable exceptions here and there in special localities where *dominicanus* is wanting or rare, the proportions of the three forms remain about the same up the east coast into British East Africa, and westward into the Uganda Protectorate. On the eastern shores of the Victoria Nyanza, however, *A. dominicanus* meets and becomes transitional into the western species *A. niavius*, with a smaller white patch (Plate III., Fig. 1), and west of the great lake we find *hippocoon* with a correspondingly reduced patch. *A. echeria* and its ally are very abundant in the Uganda forests, but somewhere west of the Protectorate they disappear, and when the coast is reached, and no doubt far into the interior as well, the *cenea* form is unknown, although *hippocoon* remains abundant and *trophonius* rare.

A new female form appears on the east of the Victoria Nyanza, becomes fairly common on the west of the lake, where it is probably next to *hippocoon* in abundance, appears on the west coast in Angola, and almost certainly occurs over the intervening area. This is the *planemoides* form recently described by Trimen, and it is of great interest inasmuch as its models are Acræine and not Danaine. One of its two models, the male of *Planema macarista*, was represented in Fig. 6 on the plate facing p. 58 of the first number of Bedrock (April, 1912). The male and female of its second model *Pl. poggei* are so similar to the male of *macarista* that the same figure gives a good idea of their general appearance. It is interesting to note in passing that these Planemas, with their striking pattern, were selected for illustration and description in the earlier article because of the influence which they exert upon the females of an *Acræa*, viz., upon a mimic remote from the *Papilioninæ* to which *dardanus* belongs. Equally clear examples of their influence in still other groups could be described if space permitted. Any hypothesis which aims to interpret the phenomena of mimicry must take into account the fact that the influence of a striking dominant model commonly

radiates into a whole circle of mimics belonging to a series of remote groups.

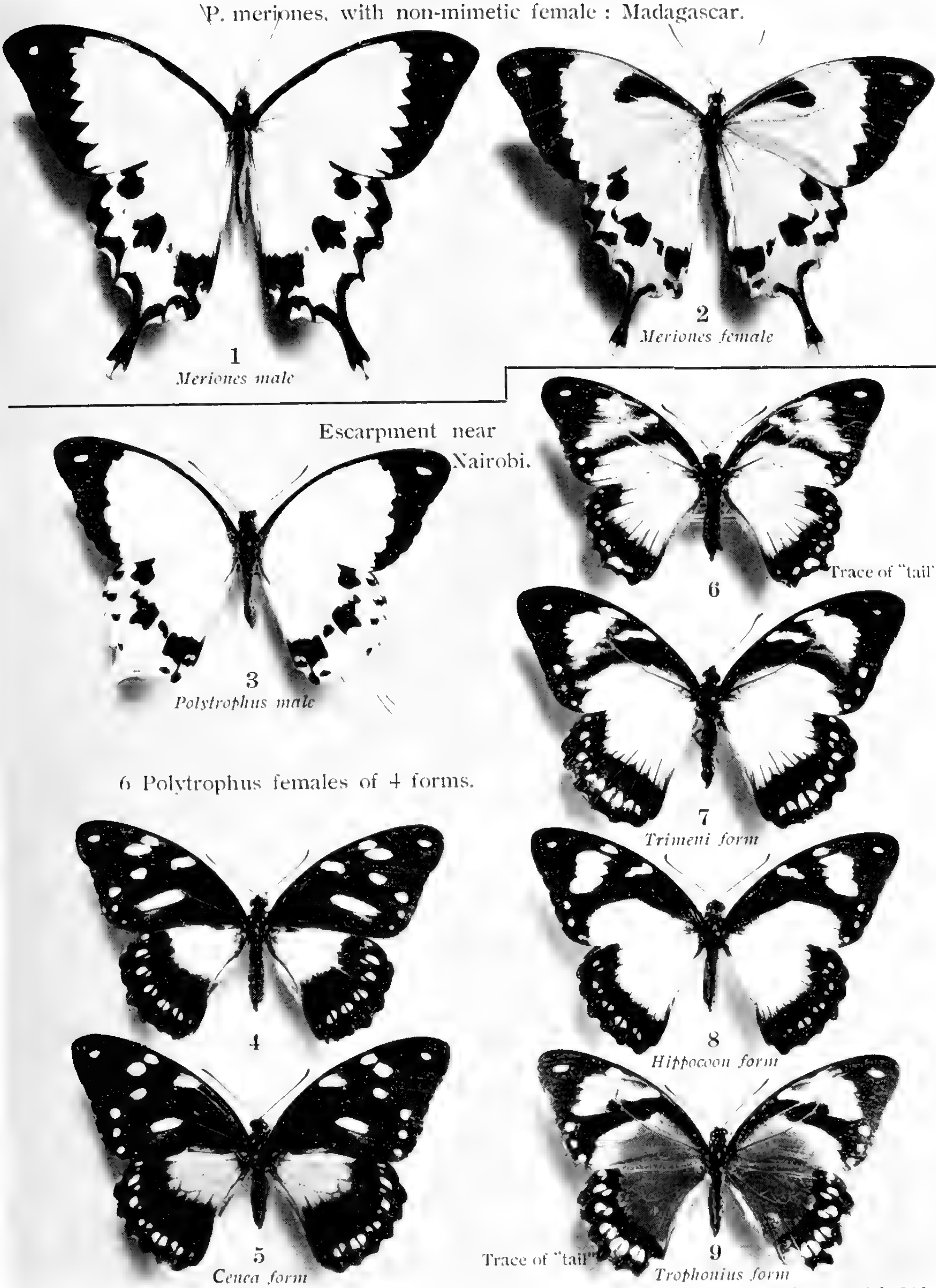
The *planemoides* female of *dardanus*, with a broad fulvous bar crossing the fore wing, and a large white patch covering the base of the hind, stands out as very distinct from the other three mimetic forms. *Planemoides* has not yet been proved by breeding to be a female form of *dardanus*,* but evidence equally strong is fortunately provided by a single specimen captured by Captain T. T. Behrens (1902—3) in Buddu, on the west shore of the Victoria Nyanza. In this specimen the pale yellow scales and black markings of the male replace the female pattern on parts of both wings on the left side. The evidence of specific identity is certainly curious and interesting, but it is conclusive. Such a fusion of characters can only occur between the male and female of the same species.

It is, as I have said, very probable that the relationship between the female forms of *dardanus* is Mendelian, and that the establishment of mimicry in various parts of the range of the species has been greatly facilitated by the fact that the female forms keep true, and do not commonly produce intermediates. Furthermore, in certain other polymorphic mimics, the Mendelian relationship may be accepted as proved. But this acknowledgment of the debt which polymorphic mimicry owes to Mendelian heredity by no means implies acceptance of the view advocated by some Mendelian writers—in particular Professor Punnett—that each mimetic pattern arose, suddenly and complete, as a mutation from the non-mimetic ancestor. To suppose that each of the forms represented in Plate I., Figs. 7, 8, 9 and 10, sprang suddenly into existence from some ancestral non-mimetic female resembling that of *P. meriones* in Madagascar (Plate II., Fig. 2)—that each of them, without adaptive adjustment, at once matched the patterns of the four

* Since these words were written, my kind friend, Dr. G. D. H. Carpenter, has obtained twenty-six eggs from a *planemoides* female on Bugalla, one of the Sesse Islands in the north-west of the Victoria Nyanza. In his last letter I heard that twenty-five caterpillars were thriving and had changed their third skins. We may anticipate that the female offspring will be chiefly or entirely *planemoides* and *hippocoon*.

March 7, 1913. As I correct these proofs I am able to add the result of this most interesting and long-sought-for experiment in breeding. In a letter received this morning, Dr. Carpenter tells me that three female offspring are *planemoides* and seven *hippocoon*.

Plate II.



Alfred Robinson, photo. Andre & Sleigh, Ltd.

Rather over half the natural size.

The non-mimetic ancestor of *Papilio dardanus (merope)* from Madagascar, and transitional forms, shewing the origin of mimetic females, from the Kikuyu Escarpment, near Nairobi, British East Africa (6,500—9,000 ft.).

Danaines shown in Plate I., Figs. 2, 3, 4, and 5, is an astounding hypothesis, and one which could never have been advanced by a writer who had studied all that is known of the *dardanus* group. A large amount of evidence has been simply ignored by Professor Punnett, and I can only assume that he is unaware of its existence. It will appear in the succeeding paragraphs that the past history of these mimetic forms can be reconstructed with singular completeness from essential phases of the past which still survive in certain parts of the vast range of the *dardanus* group.

Trimen, in his original paper, pointed out that *Papilio meriones* of Madagascar (Plate II., Figs. 1 and 2) gives us a picture of the ancestral non-mimetic form, and he suggested that the black marking on the front, or, as it is called, the costal margin of the fore wing of the female (Fig. 2), was the origin of the bar which is the characteristic feature of the *hippocoon* form. A little later another non-mimetic species, *P. humbloti*, was discovered in the Comoro Islands, and a third, *P. antinorii*, in Abyssinia and Somaliland. In both of these the female bears a black costal marking corresponding with that of the female *meriones*. The essential discovery of forms linking the above three non-mimetic females with *hippocoon*, the most ancestral of the mimics, was due to the fine collection made in 1900 on the Kikuyu Escarpment, near Nairobi, by the late W. Doherty. Here, on the heights forming the eastern boundary of the Rift Valley, the most interesting series of ancestral females has been preserved. Chief among them is the *trimeni* form (Plate II., Figs. 6 and 7), which preserves for us just the stage predicted by Trimen. In some specimens (Fig. 6) the bar crossing the fore wing is barely complete, in others (Fig. 7) it is nearly as fully formed as in *hippocoon* (Fig. 8). The colour is still pale yellow, although, as in *meriones* (Fig. 2), dingier than that of the male. But perhaps the most interesting ancestral feature is the retention in some specimens of *trimeni* (Fig. 6) of a rudimentary " tail " to the hind wing, and it is significant that *hippocoon* is the only mimetic form which I have hitherto been able to find with rudimentary " tails." Such vestiges are to be seen in two examples of *hippocoon* in the British Museum, and they appeared in two specimens of the family first bred by Mr. Lamborn. I then suggested that he should try the effect of ice upon the pupæ of a family. The experiment was very difficult to

carry out in a tropical station, seventy miles from Lagos, but Mr. Lamborn was able to maintain a temperature of about 50° F. for rather over three days. Four out of the fourteen resulting females possessed rudimentary " tails," so it is probable that some effect was produced by the shock. The *trimeni* female also occurs, although very rarely, on the East coast, and an ancestral form resembling it in the imperfect bar crossing the fore wing has long been known as *dionysus* on the West coast, where it is very rare as compared with *hippocoon*. The Kikuyu Escarpment is the only locality at present known where these transitional forms make up a large proportion of the females. Side by side with them the fully developed *hippocoon* (Fig. 8) occurs together with all the other forms, including *planemoides*. This locality is also unique in the numbers of unnamed varieties and transitional forms. The origin of *trophonius* (Plate I., Fig. 8) is well seen in the form shown in Plate II., Fig. 9—a *trimeni* female with yellowish markings and even a slight trace of the " tail," but with the great patch extending over a large part of both wings almost entirely overspread with a fulvous flush. The *cenea* female—the most specialised of all—was also probably evolved from *trimeni*; for the specimen represented on Plate II., Fig. 4, although possessing the fully developed pattern (compare Fig. 5, as also Plate I., Figs. 9 and 10), still retains the ancestral pale yellow markings. Furthermore, most of the markings in the fore wing are recognisable, although with indistinct outlines, in the fore wing of some examples of *trimeni* (compare Figs. 4 and 6 on Plate II).

The *planemoides* form probably arose in association with the origin of *cenea*, the hind wing patch becoming white, while the reduced pale markings of the *trimeni* fore wing, instead of concentrating into spots, broke through the black bar and, gaining a rich fulvous tint, fused into a broad band crossing the wing. A single example of *planemoides* obtained by the Rev. St. Aubyn Rogers in the Mombasa district, hundreds of miles east of its *Planema* models, exhibits ancestral features in the tendency of the fulvous band to divide along the line of the original black bar. In the *leighi* form which has occurred several times in Natal—twice in a single family as described on p. 44—and thus at an immense distance from the tropical model, we meet with another still more ancestral stage of

the *planemoides* female in which the fulvous band is represented by three widely separated patches corresponding in position and form with the two chief costal markings of *hippocoon* or *trophonius* and the largest oval marking in *cenea.* It is impossible to interpret *leighi* as a hybrid between one of the other female forms and *planemoides,* because the latter is entirely unknown in Natal and indeed far to the north of it.

Further important evidence in favour of the gradual building up of the mimetic forms is furnished by a careful study of the thirteen families of known parentage in the Hope Collection. We thus learn that small features in the pattern of the parent certainly tend to reappear in her offspring. I have traced this in three markings or sets of markings, but will here confine myself to one. It has been pointed out that the principal marking of the *hippocoon* female of the east (Plate I., Fig. 7 ; Plate II., Fig. 8) is very large, like that of its model (Plate I., Fig. 2), but that the same marking is much smaller in the west, corresponding with that of the western Danaine (Plate III., Fig. 1). Now Mr. Lamborn's western families of *hippocoon* females exhibit marked differences in the size of the marking, so that the majority of the females of one family are a small but distinct step nearer to the *hippocoon* of the east than is any one of the females of another family. Hereditary material exists which, given selection, could easily produce the eastern from the western mimic, or *vice versâ.* Furthermore, transitional forms are common near the zone where the one model passes into the other. It is difficult to see how the evidence of an evolution by gradual steps could be stronger than it is.

The second example is not quite so complex, and it affords a very interesting comparison with *dardanus,* inasmuch as both males and females are mimetic. The important Oriental and Ethiopian genus *Hypolimnas* belongs to the *Nymphalinæ,*—the great group of butterflies which includes our English Purple Emperor, White Admiral, and *Vanessa* and its allies, including the Red Admiral, the Peacock, the Tortoiseshells and the Comma. *Hypolimnas* is nearly related to these butterflies, and the chrysalis of the species we are considering (*H. dubia* and *anthedon*) closely resembles that of our common Vanessids. The larva too is black and spine-covered, and feeds on a kind of nettle (*Fleurya*), like many Vanessas. Nearly the whole

genus *Hypolimnas* is mimetic in one or both sexes, although this is not true of *dexithea*, an extraordinary ancestral species of huge size in Madagascar. The models are chiefly, in Africa almost exclusively, *Danainæ*. A group of African species, with both sexes mimetic and both generally alike, is sometimes separated as a distinct genus, *Euralia*, from *Hypolimnas*, in which the sexes are generally unlike and mimicry is confined to the female; but the distinction breaks down on both sides.

One of the commonest East African species of the group with both sexes alike, *Hypolimnas* (*Euralia*) *wahlbergi*, resembles *Amauris dominicanus* (Plate I., Fig. 2), while *H.* (*E.*) *mima*, a second species, as it was regarded till quite recently, mimics the two species of *Amauris* represented in Figs. 4 and 5 of the same plate. Just over ten years ago Mr. Guy A. K. Marshall published his conviction that *wahlbergi* and *mima* were a single species.* He pointed to the facts that the two forms were known to pair, that intermediates between them were known, and that he had observed them going to rest together in the evening as the individuals of some species are known to do. From that time I endeavoured to persuade African naturalists to breed the species and test Mr. Marshall's hypothesis. For many years these efforts were unavailing, one chief difficulty being the ignorance of the early stages and the larval food-plant. At length, in 1909 Mr. A. D. Millar—a distinguished Durban naturalist, whose recent death is a severe blow to African zoology —discovered the food-plant and bred both forms from the eggs laid by a female *wahlbergi* and later by a female *mima*.† His results suggested, although they did not prove, that *mima* was a Mendelian dominant, and *wahlbergi* recessive. There can be little doubt, as in *P. dardanus*, that the mimic of *dominicanus* is ancestral as compared with that of *echeria* and its ally. If we consider the genus *Hypolimnas* as a whole, especially the Madagascar species and the males that have not been modified by mimicry, we are led to conclude that the pattern of *wahlbergi* is nearer to the general type than *mima*. This affinity is especially indicated by the prevalent blue scales on the border of the white patches. Professor Punnett has discussed *walhbergi* and *mima* and their models on pp. 134—5 of the latest

* *Trans. Ent. Soc.*, 1902, pp. 491—2.

† *Proc. Ent. Soc.*, 1910, pp. xiv—xvi.

edition (1911) of *Mendelism,* where he makes the following extraordinary statement :—

> " On the modern Darwinian view certain individuals of *A. dominicanus* gradually diverged from the *dominicanus* type and eventually reached the *echeria* type, though why this should have happened does not appear to be clear. At the same time those specimens [of *Hypolimnas* or *Euralia*] which tended to vary in the direction of *A. echeria* in places where this species was more abundant than *A. dominicanus,* were encouraged by natural selection, and under its guiding hand *mima* eventually arose from *wahlbergi.*
>
> " According to Mendelian views, on the other hand, *A. echeria* arose suddenly from *A. dominicanus* (or *vice versâ*), and similarly *mima* arose suddenly from *wahlbergi*. . . . On this view the genera *Amauris* and *Euralia* contain a similar set of pattern factors, and the conditions, whatever they may be, which bring about mutation in the former lead to the production of a similar mutation in the latter."

Professor Punnett's conception of the origin of mimetic resemblance as set forth in the last-quoted sentence, has already been spoken of as a satisfactory substitute for the Darwinian interpretation, by Mr. Francis B. Sumner.* It amounts to this. A complex pattern A arose, we know not why or how, from another complex pattern B in a Danaine butterfly, while at the same time *a* (resembling A) arose from *b* (resembling B) in a butterfly of a widely removed sub-family. Although model and mimic are in every other respect widely different, in this one single but highly complex feature of pattern they are, according to Professor Punnett, identical. He tells us that the same conditions, whatever they may be, acting upon the same factors, produced the same result in these utterly different butterflies. But it is only necessary to look at the pattern of the mimic with the lens, or even critically with the naked eye, to see that in every one of its elements, it is not the same, but widely different from the model. The scaling is different, the quality of the colouring is different, the outlines of the pattern can be seen, even in the reduced reproduction of the corresponding western forms shown in Plate III., Figs. 1 and 2, to be wholly different—those of the model hard and sharp, those of the mimic soft and transitional into the dark ground-colour. If Professor Punnett's

* *The Journal of Philosophy,* New York, Vol. IX., pp. 159—61.

statement were correct, his explanation amounts to this—"It is so, because it is so." But the statement is incorrect; the patterns only *appear* to be similar, and the problem to be solved is the production of so striking a resemblance not out of the same, but out of very different elements,—the fact that model and mimic are

"Not like to like, but like in difference."

We now come to a still more obvious objection. Darwinians, according to Professor Punnett, believe that one Danaine model arose directly although gradually, from the other—Mendelians, that the origin was sudden. To suggest either the one or the other is to show a want of acquaintance with the genus *Amauris* to which both models belong. The two butterflies *A. dominicanus* and *A. echeria* are widely separated. Aurivillius in his great "*Rhopalocera Æthiopica*," places *dominicanus* (considering it to be a form of *niavius*) as the second, *echeria* as the fifteenth species of *Amauris*, and no systematist has suggested a nearer affinity. Dr. F. Moore, in fact, in his revision of the *Danainæ*,* placed *echeria* and an allied species in a separate genus, *Nebroda*. It would be interesting to know whether Professor Punnett applies his hypothesis consistently and believes that the Acræine model of the *planemoides* female of *dardanus* arose directly from one of the Danaine models (or *vice versâ*)!

In each of the examples of mimicry considered in the present article we have to deal with distinct species of models resembled not by distinct species of mimics, but by the polymorphic forms of a single species. This is one of the most interesting aspects of the question; for, as Dr. Karl Jordan has argued, there are no grounds for the belief that these polymorphic mimetic forms are on their way towards the formation of separate species. Polymorphism itself has become a character of the species, just as it has in the well-known Kallimas with their various types of dead-leaf-like under surface. It is, however, a character that is only kept up by constant selection. We have seen in *dardanus* that the absence of the model leads to the absence or the extreme rarity of the corresponding female form. And the same is true of the Nymphaline mimic; for

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* *Proc. Zool. Soc.*, Lond., 1883, p. 201.

Alfred Robinson, photo. Andre & Sleigh, Ltd.

Nearly half the natural size.

Danaine models of four species mimicked by four forms of a single Nymphaline species. Proof by breeding that the mimics are one species, and that a parent if slightly intermediate produces slightly intermediate offspring. Lagos district of S. Nigeria. (W. A. Lamborn, 1910-12.)

my friend, Rev. K. St. Aubyn Rogers, who has done so much for the Oxford University collections, informs me that in parts of the Mombasa coast district, where *Amauris dominicanus* occurs, but *echeria* and its ally are wanting, the *wahlbergi* form is common, but *mima* never seen. Moreover, about a hundred miles to the west the latter model again becomes common and *mima* at once reappears.

When Mr. A. D. Millar proved that *wahlbergi* and *mima* were dimorphic forms of one species, it became obvious, as I had suggested in 1902,* that their respective Western representatives *anthedon* and *dubia* are also mimetic forms of one species. Furthermore, in Uganda these Eastern and Western forms meet, and there can be little doubt, as Dr. Karl Jordan has pointed out, that we are concerned with a vast continuous interbreeding community,—a single species with corresponding forms modified by mimicry on the opposite sides of the Continent. The far-reaching interest of this conclusion made it all the more important to test the western forms by breeding. A set of these mimics (Figs. 6—10) with their models (Figs. 1—5) captured by Mr. Lamborn in the neighbourhood of Oni Camp seventy miles East of Lagos is shown on Plate III. *Anthedon* (Fig. 6), the western form of *wahlbergi*, is the mimic of *niavius* (Fig. 1), the western form of *dominicanus* (Plate I., Fig. 2): *dubia*, on the other hand, although obviously corresponding with *mima*, appears in three forms (Figs. 8, 9 and 10) mimicking three species of *Danainæ* (Figs. 2—5). The first form (Fig. 8), with a brown shade bordering the white patch of the hind wing, mimics *Amauris egialea* (Fig. 2); the second, more strongly marked with white, mimics the commoner form of *Am. psyttalea* (Fig. 3): the third, with the white markings reduced, especially in the hind wing, mimics *Am. hecate* (Fig. 5) and a rarer form of *Am. psyttalea* (Fig. 4), which is itself a mimic of *hecate*.

In 1911 and 1912 Mr. W. A. Lamborn bred twenty families, containing over 1,400 offspring, from known female parents, some of them *anthedon* and others including all the above-mentioned forms of *dubia*. *Anthedon* behaves as a recessive, four times producing all-*anthedon*, once all-*dubia*, and three times mixed families as it would do if it had been mated with recessives, a

* *Trans. Ent. Soc.*, p. 492.

dominant, or heterozygotes respectively. *Dubia*, in Mr. Lamborn's experience of twelve parents, always gave mixed families. A very striking result was the strong tendency of the *dubia* offspring in these mixed families to belong to the same form as the female parent. The proportions of the mixed families are sometimes in accordance with Mendelian expectation, sometimes rather strongly opposed to it. The results, as a whole, render it improbable that these exceptions are to be accounted for by the same female pairing with different males. A great difficulty in the way of the usual Mendelian interpretation is the fact that *anthedon* and the *dubia* forms predominate at different seasons. Mr. Lamborn has observed this in the field, and it is also shown in the material I have received from him.

Returning to the above-mentioned four Danaine models of the Lagos district, it would be interesting to know whether Professor Punnett considers all these four Danaine models to be a little self-contained group of the genus *Amauris* produced by direct mutation within its own limits. Any such assumption would be quite unjustifiable. *Am. niavius* stands quite apart from the others, just as its eastern form, *dominicanus*, does from *echeria;* and among the three other species the resemblance of the form *psyttalea* (Fig. 4) to *hecate* (Fig. 5) is purely superficial and no indication of affinity. This statement can be verified even from the reduced figures of the plate. The males of Danaine butterflies almost invariably possess a scent-organ which is believed to be used as an attraction to the opposite sex during courtship. In the genus *Amauris* this scent-organ takes the form of a double tuft at the extremity of the body and a patch near the anal angle of the wing—the corner opposite to the end of the body. These patches are well shown on the left side of Figs. 2—5, and it will be seen at once that both forms of *psyttalea* (Figs. 3 and 4) have a similar patch, small in size and dead black in appearance, while the distinctly double patch of *hecate* (Fig. 5) is long and glistening like the shorter one of *egialea* (Fig. 2), each half of which is seen to be distinctly concave from side to side. No resemblance in the scent-patch accompanies the likeness of the pattern of Fig. 4 to Fig. 5. There is no real approach, but only a misleading superficial resemblance. The objection to these scent-patches as criteria of specific distinction is the fact that they

are confined to one sex ; but, as regards the males, they afford a most excellent test. Furthermore, Mr. Lamborn has bred two families of *Am. psyttalea*, and in both the butterflies were nothing but *psyttalea*.

The pattern of *niavius* (Fig. 1) and its mimic *anthedon* (Fig. 6) stands widely apart from those of the other models and mimics represented on Plate III. The principal marking of the former spreads over both wings, but in the latter it is confined to the hind wing. Intermediates between *niavius* and the other models are unknown, but are not very uncommon between *anthedon* and the other mimics. A good example strongly on the *anthedon* side of intermediate is represented in Fig. 7, another strongly on the *dubia* side in Fig. 11, and its intermediate offspring in Figs. 12, 13 and 14. The pattern is continued on to the fore wing in these last four examples as a brown, and not as a white streak, and even in the original of Fig. 7 the corresponding part of the fore wing is of a pale brownish shade. Mr. Lamborn has twice bred from a female with the pattern shown in Fig. 11. The entire smaller family is represented in Figs. 12—16, and in both it and the other far larger family the *dubia* offspring strongly inherited the intermediate tendency of the parental pattern. The intermediate pattern behaved in heredity as a definite whole, and did not split up as though it were a hybrid (or heterozygote). It is reasonable to conclude that such specimens as those shown in Figs. 7 and 11 are, like *trimeni*, *leighi* and *dionysus*, relatively rare but persistent ancestral steps showing us how, under the guidance of selection, the wide gap between the pattern of *anthedon* and that of *dubia* has been crossed.

It may be safely concluded from the consideration of these two interesting and complicated examples of mimicry that the mimetic resemblance has not been produced from the original non-mimetic form by a sudden mutation, but has been the result of a series of transitional steps, some of which are still preserved.

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IX. *The study of mimicry (Batesian and Müllerian) by temperature experiments on two* Tropical butterflies. By LIEUT.-COLONEL N. MANDERS, R.A.M.C., F.Z.S., F.E.S.

[Read February 7th, 1912.]

PLATE XLI.

THESE experiments were undertaken when I was becoming impressed with the conviction that Natural Selection was not the prime factor in causing those remarkable resemblances among certain tropical butterflies which are usually classed as instances of Batesian or Müllerian mimicry.

They are not so numerous as I could wish, but as I am unlikely to be able to continue them, I bring them forward as they may be of assistance to others in future work in what I believe to be a fruitful field.

The insects dealt with form the best known case of mimicry among butterflies; the classical example of Batesian mimicry, viz. *Danais chrysippus* (model), and its two forms *dorippus* and *alcippus,* and *Hypolimnas misippus* (mimic) with its trimorphic female resembling *D. chrysippus, dorippus,* and *alcippus* respectively.

I have chosen these two butterflies as they are almost universally known to entomologists; they are not subject in any way to seasonal dimorphism; and they were common at Colombo where these experiments were carried out. The material of these experiments has been presented to the Hope Department of the Oxford University Museum, where it will be accessible to all naturalists.

It will be as well to devote a few words to the life-history of these butterflies as I have observed them in Ceylon.

Danais chrysippus.

Though the natural enemies of the perfect insect are few in number it is by no means exempt from destruction in its earlier stages. It is difficult to estimate the pressure of enemies during the egg stage, but I believe there is a gradual decrease of mortality from egg to imago in all

butterflies—from birth to maturity—thus following the general law among living beings.

The parasitic Hymenopteron *Trichogramma evanescens* is excessively common, and large numbers of eggs are found parasitised. Ants destroy them largely, more especially when fresh laid, and from these two causes alone I am inclined to consider that the damage to the *chrysippus* population is greater than in the succeeding stage. The larva which, on account of its striking appearance, is frequently selected as an example of aposematic or warning coloration, has at least two parasites; a Tachinid and a species of ichneumon (*Apanteles?*), both these are very common. They are preyed on also by a small green spider and ants, but these latter do not readily molest them unless they have been previously injured. The larvae themselves are addicted to cannibalism if overcrowded or there is a deficiency of food. In its early stages it secretes itself beneath the leaves of its most usual food-plant, *Calotropis gigantea*, eating out circular holes which readily disclose its proximity. Whether it occupies the under surface for concealment or because this is more easily masticated is uncertain, probably both factors combine; when half-grown and thence onwards it feeds exposed, and is then a conspicuous object when on the leaves, but it matches well with the purplish-green flowers on which it readily feeds. As a pupa it has fewer foes, though undoubtedly immediately after the larval skin has been cast and before it hardens it is liable to be attacked by ants and also by larvae of its own species; but otherwise it is apparently immune. It is dichroic, some being pale apple-green, the colour of the leaves, and others pale pink. The colour is not wholly susceptible to its environment as it is not unusual to find a pink pupa conspicuously suspended beneath a green leaf of the food-plant. The perfect insect has few enemies, as far as my own observations extend; lizards of the genus *Calotes* prey upon them, as they do upon any species of butterfly, and they are liable to be eaten by birds when injured.

It is one of the most widely distributed tropical butterflies and has two well-marked forms: *D. dorippus,* in which the white subapical band and black apex are replaced by the same red colour as the rest of the wing, and *D. alcippus* with its sub-form *alcippoides* in which the hindwing is more or less white.

Inspection of this series brings out the following points—

First.—The crippled condition of many of the specimens. This is due no doubt to the weakening effects of the abnormal conditions to which the pupae were subjected; the mortality varied from one in four to over fifty per cent.

Secondly.—The large number with more or less red on the apex of the forewing, which is normally black. No selection of any kind has been made, all the specimens bred, whether normal or otherwise, are represented.

Thirdly.—The marked increase of red in those treated with excessive dry heat. The ♀♀s, as in all cases, are more affected than the ♂♂s.

Fourthly.—The conspicuous red apex of two specimens treated with dry heat at 90° F., a temperature common at Colombo, where, however, the atmosphere is humid.

Fifthly.—The slight but still perceptible red on one specimen treated with dry cold.

It is probable that if as great a shock could be produced by cold as by heat the same changes would occur, showing that such are due to internal conditions rather than external causes. There is no approach, except very slightly in two specimens, to the form *alcippoides*, it is all towards *dorippus*. Two females (No. 26, No. 28) which were subjected to moist heat show an inclination to the deep dull red which is so characteristic of the species in the hot, damp climate of Sumatra and Java.

Comparing these butterflies with a large representative collection, such as the National Collection at South Kensington, one is at once struck with the almost total absence in the latter of specimens which I may call intermediate, that is, between the type *chrysippus* and the form *dorippus*. In the very large series at South Kensington I could only find two or three, though the breadth of the white subapical bar and the number and size of the white spots on the forewing is greater than in my series, and in China they are developed to such an extent as to form a well-marked local race named by Moore *Danais bowringii*. Out of the hundreds of Ceylon specimens that have passed through my hands, I have only seen one that has any red scaling on the apex, and this one I captured myself at Colombo after a long drought. Professor Poulton writes, "This variety (*dorippus*) is sharply cut off from the type form. Although faint traces of a former white bar can be made out in *dorippus*, I have never seen, among thousands

of individuals, the material out of which a good transitional series between it and *chrysippus* could be constructed" ("Essays on Evolution," p. 70).

As to the factor which produced these intermediates, Professor Poulton, in a letter to me, writes, "The species (*chrysippus*) has a double constitution A and B, developed from internal causes (viz. within itself, and hereditary), but they are not so far crystallised out but what some effect in the direction of A or B may be produced by external causes; but not apparently the whole effect—at least so far as you have gone." And again, "I do not change my view that the ultimate cause is internal and not external. That the internal condition can be modified to some extent your experiments certainly seem to show; although you do not produce the full *dorippus* effect, whatever you do. The full *dorippus* form is a dominant one on Kilimanjaro, with all its mountain moisture, showing, I think, that it is not heat and dryness that produce it. The same conclusion is supported by the fact that *dorippus* is extremely rare south of the Zambesi, although there are vast tracts of land that are dry, hot, and desert, for a large part of the year. Hence, although the germ-plasm seems certainly alterable by heat, that does not seem to be the way that usually works in nature. It may be so in the desert area of Ceylon, accounting for the isolated individuals that occur there of *dorippus*. *Inaria* is even more clearly independent of climatic causes, for its proportion is considerable all over Africa; yet the climate varies immensely. It is a common form on the West Coast."

I quite agree that the cause is internal and hereditary, but rather consider that the constitution is simple and that an external cause such as shock to the developing pupa throws it back to an earlier form of its internal development. That external conditions have in themselves power to produce some effect is indicated by the approach to the Sumatra form by the agency of moist heat, and Mr. Merrifield has shown by his experiments on *Chrysophanus phloeas*, that that butterfly is ready to assume a different colouring according to the temperature at which the larva is reared. But in the present state of our knowledge it is frequently impossible to say what is due to internal causes and what to the pressure of external conditions.

The question arises which is the ancestral form, *chrysippus* or *dorippus*? Most entomologists, I believe, consider the

former to be the older, chiefly on the grounds that the latter is widely different in appearance from any now existing member of the group, and that in certain specimens the remains of a former bar are more or less visible. I do not know that either of these objections is insuperable, but if so, I can only assume that the germ-plasm has now become so fixed by inheritance that no form of shock can throw it backwards to an earlier type, but only disturbs it to such an extent as to cause it to produce the easiest variation of which it is now capable.

On the other hand, all experimenters on the earlier stages of European *Lepidoptera,* Weismann, Merrifield, Standfuss, and others, lay great stress on the fact that shock tends to throw the insect towards the ancestral type, and I certainly know of no detailed experiments to the contrary. It is scarcely reasonable that the same agent would throw one insect back to the type, and another to the form towards which it is tending. There is one fact recently brought to my notice by Mr. Doncaster of great importance. He tells me that he has received from Coimbatore, in the Madras Presidency, a brood of bred *chrysippus* in which were a considerable number of *dorippus,* the parent being the type. This is the first instance of such an occurrence, and it is the more interesting as *dorippus* has never to my knowledge ever been taken in Madras. I regard these *dorippus* as a throw-back to the ancestral form. We shall see that we shall be confronted with precisely the same difficulty when dealing with *Hypolimnas misippus.* It is, however, clear that neither form is a sudden mutation, but has been formed gradually the one from the other.

Hypolimnas misippus.

Few remarks are needed regarding its life-history, but I give the following from my note-book to show the rapid growth of the larvae, and the remarkably short time during which Natural Selection can have any influence on the mature butterfly. It will be noticed that the female lays the whole of her eggs in about ten days.

"17.10.09. Captured *diocippus* ♀ in cabinet condition.

20.10.09. Noticed a considerable number of eggs laid.

24.10.09. Several larvae are hatched and evidently a day or two old, if not older. Transferred ♀ to another cage.

29.10.09. Many of the larvae are half-grown. She is still ovipositing. To-day I collected over 100 eggs, laid since the 24th. Transferred to another cage.

2.11.09. No more eggs laid.

4.11.09. Found dead, apparently from natural causes. Two larvae pupated to-day; the pupation of larvae from eggs first laid is practically coincident with the length of oviposition."

It only appears in Ceylon directly after the rain, at the burst of the North-East Monsoon, and dies out with it. It has occurred the last four years with extraordinary regularity; in 1908 early in October; 1909 on October 12th; 1910 on October 12th; 1911 on October 7th. They always appear in considerable numbers and in the finest condition, and are no doubt bred on the spot. It flies commonly in November, gets scarce towards the end of December, by which time the females have mostly disappeared, and the last few males die out towards the end of January, not to be seen again until the following October. Males and females are equally numerous, the males frequenting flowering shrubs, and the females more open ground in the neighbourhood of the food-plant, *Portulaca oleracea*. It is in such country that its presumed model, *D. chrysippus*, occurs, and it is not uncommon for the *chrysippus* ♂ to mistake the *misippus* ♀ for one of its own species. Butterflies recognise each other by sight as well as by scent; the smell of a crushed *misippus* is very different from that of *chrysippus*. It is not rare for *misippus* ♂ to court for a few moments *D. chrysippus*.

The form of female which represents *D. chrysippus*, form *dorippus*, known as *inaria*, Cram., is distinctly rarer than the female of the type *diocippus*, Cram., which resembles *chrysippus*. In Colombo, in eight years, I have not seen a dozen specimens; but Mr. Ormiston tells me that in his part of the country at 4,500 ft., the proportion is about one of *inaria* to six of the type. Intermediates are rare; I picked out one in a collector's box which had the white apical bar thickly covered with reddish scales, but have never taken one myself or known of one taken by others.

It was advisable to ascertain the normal number of *inaria* in a batch of eggs laid by *diocippus* and *vice versa*, but unfortunately I was unable to find a single specimen

of *inaria*. In October 1909 from a normal *diocippus* ♀ I obtained 250 eggs; there were 50 deaths from one cause or other and 197 resulting butterflies, 110 ♂♂s and 87 ♀♀s, all without exception of the *diocippus* form. In October of the following year I bred 225 from another female of the same form; the result was 84 ♂♂s and 76 ♀♀s, all typical *diocippus*, except five which were slightly speckled with red on the three small apical spots on the forewing; the remainder of the brood, 65 in number, I experimented with. (C1, C1a, etc.)

These results contrast in a most remarkable manner with those of the Rev. St. Aubyn Rogers in East Africa. He writes to me, "From an intermediate between the type and *inaria* form, but on the whole nearer the former, I obtained about 50 ♂♂s and 49 ♀♀s, but all *inaria*, some slightly *alcippoides*. In the following year an *inaria* laid 100 eggs, resulting in 60 ♂♂s and 36 ♀♀s, the whole *diocippus*! Weather dry." He added, "If *inaria* is the dry weather form (as I had surmised it being so uncommon in damp Ceylon), the offspring should be *inaria*." *

Mr. G. F. Leigh in Natal obtained from an intermediate female 8 ♂♂s, 5 *diocippus* and 3 *inaria*.

These results probably have a Mendelian interpretation, but they throw no light on the origin of these two forms.

Turning now to the results obtained; the butterflies exhibited are labelled A, B, C, C1a, etc.

Those labelled A, consisting of 9 ♂♂s and 55 ♀♀s, the parent of which is also shown, form *diocippus*, are part of the brood of 197 bred in October 1909, and show the normal appearance of the species as it occurs in Ceylon. They are in no way selected.

Those labelled B were from a similar parent to A, and only a few eggs were laid. They were all treated artificially, but as it was open to any one to say that they might have produced these abnormal forms under natural conditions, I took a third brood C, which I divided into two. One half was reared under natural conditions and produced all normal ♂♂s and *diocippus* ♀♀s; the other half I again divided into two, treating one portion artificially in the

* In a subsequent letter dated 23.11.1911 he writes, "I got a ♀ of the type form from which I bred 73 ♂♂s and 56 ♀♀s, of which 38 were of the type form and 18 of the *inaria* form and *no* intermediates." See Proc. Ent. Soc., 1911, p. xliv, and also 1912, p. lxxiii.

early stage of pupal life, and the other in the later stage. I should say the parent was of the type form. The whole of the abnormal specimens can be treated collectively.

The first noticeable point is the large number of cripples and malformed individuals. The mortality among those artificially treated was very high. *Misippus* is very hardy, and easy to breed, and there is no difficulty in obtaining large numbers of normal butterflies, but abnormal conditions have a great effect on them. The difference between the two was very marked, the latter often dying just before emergence, or with very little power of breaking through the pupa case; their movements after emergence were excessively feeble compared with the others. Taking the females first, the number of intermediates, *i.e.* with the apices and white band of the forewing speckled with red, is very large. Though such are not unknown in East Africa, it is significant of their rarity that in the National Collection I could only find one from Aden, one from Muscat, and one from Berhampore. In this series there is a gradual increase of red, from a few scattered scales in the black apex, to a complete change from one form to the other. I would also call attention to the character of the subapical band. Normally it is a slight curve from the costa to the outer margin, and is composed of separate spots divided by the black veins, but in these it is distinctly broader, longer, and more circular, and the spots are united into one continuous band. This is the normal appearance of the ♀ in certain areas of its distribution, for instance, at Port Darwin, the Cocos Keeling Islands, Java, and Sumatra, and in the latter islands the forewings are often of the same deep red colour as *D. chrysippus*. There are three noticeable features in the males. First, the appearance of a small white spot in the cell of the forewings, and in two or three specimens there is a second. These are extremely rare in the normal butterfly, which is exceedingly constant in colouring. Secondly, the rather more prominent and extensive lunular subterminal lines on the upper side of the hindwings. Thirdly, the less intense black of the tornus in the forewing underside, which in one specimen is distinctly red. In none is there any red on the forewing.

Comparing these males with those in the South Kensington Museum, I find a solitary specimen from the Silaki Valley, British East Africa, with a small amount of red at the base of the forewing upperside, and the lunules well

marked on the hindwing. From the island of Formosa there are two males like the above, and the tornus beneath is red. Whether this is the usual form of the insect in that island I am unable to say. In constructing the ancestral type, we should probably be on safe ground by assuming that it had more white and a certain amount of red on the forewing, a lunulated band completely round the outer margin of the hindwing, and more red on the underwing. Anything beyond this is conjectural.

Referring for a moment to the females, it will be seen that in the forced specimens there are in the blue costal margin of the cell, two spots, sometimes red, sometimes white, in precisely the same position as the two white spots in the cell of the males. These are absent, or nearly so, in normal specimens, and we may conclude that, at one time in its history, the female had more white on the forewing than it has at present. This would rather incline us to the view that *diocippus* is the earlier form, but, as in *chrysippus*, we are confronted with the difficulty that shock throws back the insect to the earlier stage, in which case, judging by these intermediates, *inaria* is the more ancient type, and we must account for these additional spots by the not improbable conjecture that the evolution of such a variable butterfly has not been uniform.

The study of the closely allied species *Hypolimnas bolina* may help us in our determination of this question. It is difficult in a few words to give a brief, and at the same time lucid, account of the innumerable variations of this protean butterfly. The male, throughout its immense range, is very fairly constant, being very similar in general appearance to that of *H. misippus.* In Fiji the spots are very small, and a very deep blue. The females in their western area do not vary greatly, being generally plain brown and slightly blue on the costa, with a variable number of marginal yellow spots. In Formosa the colour is also plain brown, sometimes tinted with blue, and with a white band as in *misippus.* Further east, in the Loochoo Islands, the brown is replaced with glistening blue. But it is in Australia and the Fiji Islands that the butterfly reaches its maximum development both of size and variability. In the Godman-Salvin Collection, now in South Kensington, there is a series of some two dozen females, taken at Suva, Fiji, on the same day and on the same flower bed. All are different, and vary from plain

brown, or plain brown with yellow or white discal band, to others with bluish white discal spots, and red on the forewing. In Australia, very much the same sequence is observed. It varies from a plain brown butterfly with slight blue on the costa and disc, to a highly variegated metallic red, white, and blue butterfly. We can, in this extensive series, trace the gradual change from a few scattered red scales, to a well-developed red band or patch.

There is an intimate relation between the colours brown and blue in all butterflies. So far as my own knowledge extends, there is no blue butterfly in the world that, in one or the other sex, has not some traces of brown. Blue, if I may so express it, is a later colour than brown. It is well exemplified in the European *Lycaenidae.* This being so, we may consider ourselves justified in assuming that the plain uniformly brown female represents the oldest known form of that sex of *bolina* at present existing. It seems a natural conclusion that the uniformly coloured *inaria* is also an older form, from which the more variegated *diocippus* has been evolved. As in the case of *D. chrysippus,* it is clear that it is not a sudden mutation.

Now as to the factor which has caused the resemblance between the two species; is it Natural Selection, or what?

The argument for the former, that is, Mimicry, has been elaborated by Prof. Poulton, in his well-known work, "Essays on Evolution," and it is unnecessary to recapitulate or to discuss whether this is a case of Müllerian or Batesian mimicry. But further, there are the two forms *dorippus* and *alcippus,* which are also held to be due to Natural Selection, and I will consider them first.

Danais chrysippus form *dorippus.*

In the above Essays (p. 320), Prof. Poulton has put forward the view that *dorippus* has been evolved from *chrysippus* as a form of cryptic defence; that is, though it is an unpalatable insect, the struggle for existence is so great in the desert areas in which it is usually found, that it has been necessary for its survival to discard the conspicuous white band and black apex, and make itself as near as may be to the colour of its environment.

I am doubtful as to this interpretation. In the extremely hot dry weather of the desert, the butterfly, like the majority of other insects, altogether disappears; birds shift their quarters; and reptiles and predatory insects become scarce. During the short rainy season, or, for that matter, after a few showers, insect and other life becomes very abundant for a short time, during which I doubt there being a greater struggle for existence than in other places where the type is found. Insects, though few in species, are particularly numerous in individuals, the members of the genus *Teracolus*, for instance, are frequently excessively common.

If *dorippus* is a desert form particularly fitted for such a life, we should expect it to be dominant in the Punjab,* Bikanir, and Rajputana deserts, where, if it occurs at all in the latter places, it is exceedingly rare, though the type is common enough. We should also expect it to be common on the hot dry plains of Mashonaland and other similar localities south of the Zambesi, but on the contrary, it is very rare, though the type is abundant.

Again, presuming that it is a later form, it is difficult to account for the absence of intermediates. The accepted interpretation would be, I presume, that they are not so fitted for a desert life. If this be so, we must assume an æsthetic eye for small differences in colour and pattern, on the part of birds and other enemies, for which the evidence is at present deficient.

I hold the view that the sporadic character of much of its distribution, the production by artificial means of intermediates, and that it has been bred from *chrysippus*, clearly show that it is the ancestral form; and though we are ignorant as to its origin, and the nature of its evolution, the proof that it has been guided by Natural Selection has not been satisfactorily demonstrated.

D. chrysippus form *alcippus*.

Prof. Poulton, in the above mentioned work, considers that the white hindwings of the form *alcippus* have been developed on the West Coast of Africa, where in some localities it is dominant, to give it greater conspicuousness where there is abundance of food, and thus warn

* Colonel Yerbury took two or three specimens at Campbellpore, in the north of the Punjab. They are now in the National Collection.

off a possible enemy; in other words, it comes under that form of mimicry known as aposematic or warning coloration.

There are, however, certain features in its area of distribution, which, to my mind, render this doubtful. I certainly found it, or its sub-form *alcippoides*, commonly in North-East Sumatra, where rain falls every week in the year, and it is also common and very variable in the Andaman Islands, where the general conditions are also like those on the West Coast. But it is absent from a similar environment in Ceylon, yet is found, though rarely, in the arid northern district of the island. *Alcippoides* is by no means uncommon in the bare plains of the Deccan and Madras, where the country is totally different from the West Coast.

The view that an aposematic colouring is necessary in one region and a cryptic colouring in another, both produced by the same factor, is complicated and not easy to understand, and I know of no direct evidence to support such a conclusion. The necessity for it in an insect so unpalatable, as *chrysippus* is generally held to be, is not lessened when we remember that the cryptic form is not uncommon in Bombay, and the conspicuous one is common in the adjoining Presidency of Madras, where the local conditions are almost identical.

These experiments throw little light on the origin of this form, though there is one specimen which shows an approach to it; *dorippus* also sometimes shows white on the hindwings, and it is possible, though this is a little more than conjecture, that it is the earliest form from which *chrysippus* has branched off in one direction and the white winged forms in another. The evidence that either has been influenced by Natural Selection is at present, to my mind, unconvincing.

Finally, as to the main question; the relationship of these two butterflies to each other; whether they have arrived at their present appearance by any form of mimicry; or whether their resemblance can be otherwise accounted for.

There is in this case, as in all similar examples of mimicry, the primary difficulty of understanding how small variations of colour or pattern in one butterfly could be so elaborated by the attacks of birds as to resemble the colour or pattern of another unrelated to

it. In the example before us, remembering the short ten days in which Natural Selection has to act, and presuming that in some time past the *misippus* ♀ was somewhat similar to the ancient type of the ♂, we may ask, how could a specimen, or specimens, with a few red scales scattered over the wing, be noticed and subsequently avoided by birds, by any lesson they may have previously learnt from the capture of *Danais chrysippus*?

On the assumption that this is a case of Batesian mimicry, a bird tasting a red speckled specimen, would ascertain at once that it was palatable, and the red scales in others would not save them from destruction. The likeness towards *chrysippus*, therefore, could not progress.

If it is a case of Müllerian mimicry, where both species are unpalatable, a red speckled unpalatable one, as also its unspeckled companions, after a few experiments, would be left severely alone and nothing would be gained, for if the bird could discriminate it would neglect them, and if it could not, both would equally suffer.

Lastly, if the resemblance is due to the experimental attacks of young birds, the emergence of the butterflies should coincide with the time that tasting experiments are taking place, but in Ceylon it so happens that the young birds are off the nest and foraging for themselves in May, and *misippus* is not on the wing until October.

We could the more readily understand the process if the mutation was sudden and large, but the specimens exhibited negative such a supposition.

Some supporters of the mimicry theory, among others Mr. Pocock and Prof. Poulton, consider "that the first steps towards a mimetic likeness are not caused by a few differently coloured scales," but "by a large colour variation which was enough to produce a rough resemblance, and that Natural Selection gradually produced out of this a detailed resemblance." At first sight this looks like mutation pure and simple, but it is not necessarily so.

The evolution of the species is internal, and the large variation Prof. Poulton speaks of may be the cumulative effects of an increasing number of differently coloured scales in many generations. We have only to assume the disappearance of such intermediates to arrive at a "large colour variation."

I see nothing that prevents our believing that if internal evolution can produce a large variation, a continuance of

the same process would in the course of time produce a butterfly quite unlike the type from which it arose. This may be so in the case of these two butterflies, but the evidence here produced rather supports the conclusion that the changes in them have been caused by the gradual accumulation of small variations; this being so there would seem to be no necessity for bringing in the complicated theory of mimicry to account for the resemblance between these two species of butterfly.

I have recently published a paper * on Batesian and Müllerian Mimicry, in which I examined the subject from the point of view of my own personal knowledge of certain tropical countries. I can only say here, and as briefly as possible, that I was unable to throw anything but a negative light on the premises on which those theories are based, and that some of the conclusions I arrived at were, that though butterflies are more generally eaten by birds than was generally believed, yet no discrimination was shown in their capture; that the presumed unpalatable Danaines were as readily eaten as other species of butterfly, and that the few species of birds I could experiment on in a wild state eat *Danais chrysippus* as readily as *Hypolimnas misippus*.

The circumstance that in life the ♀ *misippus* frequently consorts with *chrysippus*, and may thus lead one predisposed to believe in mimicry that he had before him a Müllerian combination, is explained by the fact that the food-plants of both butterflies grow together in the same sandy soil. Should any observer watch them in such situations, as I have done for hours at a time during the last three years, he will find that they are practically unmolested by birds, young or adult.

I conclude that *dorippus* and *inaria* are the older forms from which have descended *chrysippus* and *diocippus* respectively. Both survive to the present day, practically all over the wide distribution of the species, because like their descendants they are for the time being almost exempt from the struggle for existence. If it were possible to dissect a pupa in the same way as we can the embryo of a mammal, we should find traces of these intermediates and regard them as the remains of a stage beyond which the species has now progressed.

* Proc. Zool. Soc. Lond., May 1911.

Conclusions.

1. *D. dorippus* and *H. inaria* are the older forms of *D. chrysippus* and *H. misippus* (*diocippus*) respectively.

2. That the latter have been produced by the gradual accumulation of small variations.

3. That these small variations (intermediates) have now largely died out as being no longer required.

4. That they can be reproduced by shock (heat and cold) to the pupa.

5. That there is nothing to show any interdependence, or anything in common between the two species.

6. That though this is so with these two species it is difficult to believe that such is the case with all instances of mimetic resemblance.

7. That though no doubt the mimetic theory gives a logical explanation of them, the premises on which it rests have not been proved, but rather the contrary.

Explanation of Plate XLI.

[*See Explanation facing the Plate.*]

EXPERIMENTS WITH *DANAIS CHRYSIPPUS.*

"Dry Cold." (Placed under normal atmospheric conditions after removal.)

No.	Placed in.	Date.	Date of removal.	Date of emergence.	Remarks.
1*a*	58° F.	4.12.08	6.12.08	?	♂. Normal.
2*a*	,,	5.12.08	,,	6.12.08	♂. ,,
3*a*	,,	,,	,,	,,	♂. ,,
4*a*	,,	26.12.08	28.12.08	4.1.09	♀. ,,
5*a*	Full fed larva.	19.12.08	21.12.08	8.1.09	♀. ,,
9	Pupa. 50° F.	18.6.09	21.6.09	27.6.09	♀. Apex slightly reddish, not black.
10	,,	,,	,,	,,	♂. Normal.
11	,,	,,	,,	,,	♀. ,,
12	,,	,,	,,	,,	♂. ,,
15	,,	,,	,,	28.6.09	♀. ,,
16	,,	,,	,,	,,	♂. ,,
17	,,	17.6.09	,,	,,	♂. ,,
18	,,	,,	,,	,,	♀. Spot beyond cell duplicated.
19	,,	18.6.09	21.6.09	,,	♂. Normal.
20	,,	17.6.09	,,	,,	♂. ,,
21	,,	18.6.09	,,	,,	♀. Black on margin of hindwing broader than usual.
22	,,	17.6.09	,,	,,	♀. Normal.
23	,,	,,	,,	,,	♀. ,,
24	,,	15.6.09	,,	,,	♂. Spot beyond cell duplicated, hind margin more extensively black.
25	,,	,,	,,	,,	♀. Normal.
13	,,	,,	,,	27.6.09	♀. ,,
14	,,	17.6.09	,,	,,	♀. Spot beyond cell duplicated.

"Moist Cold." (Placed under normal atmospheric conditions after removal.)

NO.	PLACED IN.	DATE.	DATE OF REMOVAL.	DATE OF EMERGENCE.	REMARKS.
26	50° F.	21. 6. 09	26. 6. 09	30. 6. 09	♀. Very faint trace of red along the nervures at lower portion of black apical patch.
27	"	"	"	"	♂. Normal.
28	"	22. 6. 09	"	1. 7. 09.	♀. "
29	"	"	"	"	♂. "

"Dry Heat." (Placed under normal atmospheric conditions after removal.)

No.	Placed in.	Date.	Date of removal.	Date of emergence.	Remarks.
30	113° F.	13. 7. 09	14. 7. 09	21. 7. 09	♂. Normal. Temp. doubtful.
31	110° F.	12. 8. 09	14. 8. 09		Died.
32	,,	13. 8. 09	,,		,,
33	,,	,,	,,		,,
38	,,	,,	,,		,,
39	,,	,,	,,		,,
1	90° F.—95° F.	19. 6. 09	21. 6. 09	24. 6. 09	♂. Normal.
2	,,	,,	,,	25. 6. 09	♂. ,,
3	,,	,,	,,	,,	♀. Black of apex partially replaced by red.
4	,,	,,	,,	26. 6. 09	♂. Black apical patch distinctly red along the nervures. Ground-colour rather paler than normal.
5	,,	,,	,,	,,	♀. As No. 3, but red at apex brighter. Pale colour of base and disc extends into lower half of cell. Margin of hindwings almost entirely black.
6	,,	20. 6. 09	21. 6. 09	,,	♀. Normal, except a slight indication of red along apical veins.
7	,,	,,	,,	,,	♀. As No. 5.
8	,,	,,	,,	,,	♂. Normal.
34	96° F.	1. 9. 09	3. 9. 09	7. 9. 09	♀. Upper portion of apex very slightly, lower portion slightly red.
90	100° F.	5. 8.	7. 8.	11. 8.	♂. Apex distinctly red. Hind margin of secondaries almost entirely black.
91	,,	,,	,,	12. 8.	♂. Normal. Hind margin of secondaries narrowly black, no white.
94	,,	,,	,,	14. 8.	♀. Normal.
54	102° F.	3. 3. 10	5. 3. 10	9. 3. 10	♂. Apex distinctly red.

55	102° F.	7. 3. 10	9. 3. 10	12. 3. 10	♀. Apex bright red.
56	,,	6. 3. 10	,,	8. 3. 10	♀. ,, reddish.
57	,,	3. 3. 10	5. 3. 10	,,	♀. ,, very slightly red.
58	,,	,,	,,	9. 3. 10	♂. ,, ,, ,,
59	,,	7. 3. 10	9. 3. 10	13. 3. 10	♂. ,, very bright red.
60	,,	3. 3. 10	5. 3. 10	12. 3. 10	♂. ,, red.
61	,,	,,	,,	8. 3. 10	♀. ,, slightly red.
62	,,	3. 3. 10	5. 3. 10	8. 3. 10	♂. ,, very slightly red.
63	,,	,,	,,	11. 3. 10	♂. ,, bright red.
64	,,	4. 3. 10	6. 3. 10	12. 3. 10	♀. ,, ,,
65	,,	3. 3. 10	5. 3. 10	9. 3. 10	♂. Normal.
66	,,	,,	,,	,,	♂. Apex slightly red.
67	,,	4. 3. 10	6. 3. 10	11. 3. 10	♂. ,, distinctly red.
68	,,	3. 3. 10	5. 3. 10	9. 3. 10	♂. ,, ,, ,,
69	,,	4. 3. 10	6. 3. 10	10. 3. 10	♀. ,, slightly red.
70	,,	3. 3. 10	5. 3. 10	8. 3. 10	♀. ,, ,,
71	,,	,,	,,	12. 3. 10	♀. ,, bright red.
72	,,	4. 3. 10	6. 3. 10	11. 3. 10	♀. ,, ,,
73	,,	3. 3. 10	,,	,,	♂. ,, ,,
74	,,	,,	,,	10. 3. 10	♂. ,, ,,
75	,,	,,	,,	8. 3. 10	♀. Normal.
76	,,	,,	,,	9. 3. 10	♂. ,,
77	,,	,,	,,	10. 3. 10	♂. Apex distinctly red.
78	,,	4. 3. 10	,,	12. 3. 10	♂. ,, ,,
35	105° F.	4. 9. 10	6. 9. 10	13. 9. 10	♀. Almost entire replacement of black at apex by bright fulvous. All white spots diminished, fulvous interval in subapical band, submarginal spots below absent.
36	,,	5. 9. 10	7. 9. 10	,,	♀. ,, ,, ,, ,,
37	,,	,,	,,	14. 9. 10	♂. Very similar to above : spots at apex obsolescent.

"Moist Heat." (Placed under normal atmospheric conditions after removal.)

No.	Placed in.	Date.	Date of removal.	Date of emergence.	Remarks.
88	102° F.	24. 7. 10	26. 7. 10	1. 8. 10	♀. Normal.
89	"	"	"	"	Died.
92	101° F.	5. 8. 10	9. 8. 10	12. 8. 10	♂. Normal, but hind margin of secondaries narrowly black, no white.
93	"	"	"	"	♂. Apex reddish.
95	"	12. 8. 10	16. 8. 10	17. 8. 10	♂. Normal.
96	"	"	"	18. 8. 10	♂. "
97	"	"	"	"	♀. "
98	"	"	"	"	♂. "

"VARYING CONDITIONS." (Placed under normal atmospheric conditions after removal.)

NO.	PLACED IN.	DATE.	DATE OF REMOVAL.	DATE OF EMERGENCE.	REMARKS.
40	{ 2 hours. 60° F. / „ 108° F. }	28. 9. 10	28. 9. 10		Died.
44	{ 4 hours. 60° F. / 3 „ 105° F. }	13. 10. 10	13. 10. 10	20. 10. 10	♀. Normal.
45	„	„	„	„	♂. „
46	„	„	„	„	♀. „ but two spots beyond cell, upper very small.
47	„	„	„	„	♂. „
48	„	„	„	„	♂. „
49	{ 3 hours. 60° F. / 7 „ 110° F. }	15. 10. 10	15. 10. 10	„	Died.
50	„	„	„	22. 10. 10	♀. Normal.
51	4 hours. 110° F.	18. 10. 10	18. 10. 10	„	Died.
52	„	„	„		„
53	„	„	„		„
79	{ 24 hours. 58° F. / 24 „ 102° F. }	19. 7. 10		30. 7. 10	♂. Normal.
80	„	„		„	♀. „
81	„	„		„	♀. „
82	{ 48 hours. 102° F. / 24 hours normal. }	23. 7. 10		„	♂. Apex slightly red.
83	48 hours. 102° F.	„		„	♀. „ „ „
84	„	„		„	♀. Apex well marked with red, subapical white band also reddish.
85	„	„		31. 7. 10	♂. Apex slightly red.
86	„	„		„	♂. „ „ „
87	„	„		„	♀. Apex almost entirely red, subapical white band reduced; ground-colour of wings paler, especially to inner side of white band; indication of white along veins of hindwings approaching *alcippoides*.
41	{ 2 hours. 60° F. / 2 „ 108° F. }	28. 9. 10	28. 9. 10	6. 10. 10	♂. Apex slightly red.
42	„	2. 10. 10	2. 10. 10	8. 10. 10	♂. „ „ „
43	„	„	„		Died.

EXPERIMENTS WITH *HYPOLIMNAS MISIPPUS.*

"DRY" normal (77° F.) air. Parent *diocippus.*

NO.	PLACED IN.	DATE.	DATE OF REMOVAL.	DATE OF EMERGENCE.	REMARKS.
1	77° F.	21. 11. 08		29. 11. 08	♂. Normal.
2	,,	,,		,,	♂. ,,
3	,,	,,		,,	♀. *inaria.*
4	,,	,,		28. 11. 08	♂. Normal.
5	,,	27 ,,		8. 12. 08	♀. Type.
6	,,	29 ,,		4. ,,	♂. Normal.
7	,,	29 ,,		4. ,,	♀. Type.

"DRY COLD." B. Parent *diocippus.*

NO.	PLACED IN.	DATE.	DATE OF REMOVAL.	DATE OF EMERGENCE.	REMARKS.
8	25° F.	1. 12. 08	2 12. 08. to 60° F.	12. 12. 08	♂. Distinct extension of the blue-white discal spot on to costa of forewing.
9	60° F.	2. ,,	6. 12. 08.	13 ,,	♂. Similar to above but not so distinct.
10	,,	,,	,,	,,	♀. Type, rather small and dark.

"Dry Heat." Dry bulb 99° F., wet 84°. (Outside air dry bulb 83° F., wet 79°.)

No.	Placed in.	Date.	Date of removal.	Date of emergence.	Remarks.
1	As above.	10. 11. 09	11. 11. 09	17. 11. 09	♂. Normal.
2	„	11. „	13. „	Died.	
3	„	11. „	13. „	18. 11. 09	♂. Normal.
4	„	12. „	15. „	19. „	♂. „
5	„	13. „	18. „	20. „	♂. Small white spot centre of cell, forewing.
6	„	13. „	„	„	♀. Cripple; apical white band broader and continuous, *i. e.* veins white not black.
7	„	13. „	„	„	♀. Apical band as above, extreme apex reddish.
8	„	13. „	„	„	♀. Apical band reddish, apex reddish; the two red spots in black costal band.
9	„	13. „	„	„	♀. As No. 7.
10	„	14. „	17. „	19. „	♂. As No. 5.
11	„	14. „	„	21. „	♂. „
12	„	14. „	„	„	♂. „
13	„	15. „	19. „	22. „	♂. „
14	„	15. „	„	„	♀. Apical band reddish white, considerable red scaling at apex; black area between band and disc much diminished.
15	„	15. „	„	Died.	

CI. Parent *dioeippus*. "DRY HEAT." 101° F. 24 hours after pupal change.

NO.	PLACED IN.	DATE.	DATE OF REMOVAL.	DATE OF EMERGENCE.	REMARKS.
1	As above.	7. 11. 10	10. 11. 10	14. 11. 10	♂. Upperside forewing, two bluish white spots in cell, the inner smaller; upperside hindwing, blue scaling at tornus more extensive and distinct indication of lunular line as in ♀. Underside hindwing, central band yellowish, not pure white with black scaling, basal and subterminal bands decidedly light red.
2	,,	,,	,,	,,	♂. One small spot in cell; cripple.
3	,,	,,	,,	,,	♀. Type. White band more dentate on inner side and curved inwards at lower extremity; not straight.
4	,,	,,	,,	,,	♀. ,, Cripple.
5	,,	,,	,,	,,	♀. Well marked intermediate; band rufous, shape as No. 3. Apex speckled with red.
6	,,	,,	,,	,,	♀. As No. 3.
7	,,	,,	,,	,,	♂. Small bluish white spot in cell.
8	,,	,,	,,	,,	♂. ,, ,,
9	,,	,,	,,	,,	♂. ,, ,,
10	,,	,,	,,	,,	♂. ,, ,,
11	,,	,,	,,	,,	♀. As No. 5.
12	,,	,,	,,	,,	♂. As No. 2.
13	,,	,,	,,	,,	♂. ,,
14	,,	,,	,,	,,	Cripple.
15	,,	,,	,,	,,	♂. As No. 2.
16	,,	12. ,,	15. ,,	19. ,,	♂. As No. 1, but only one spot in cell.
17	,,	,,	,,	,,	♂. As No. 1, but underside of tornus forewing red not black, and more black on underside of hindwing.
18	,,	,,	,,	,,	♀. Band thickly speckled red upper part, red scales in black apex.
19	,,	,,	,,	,,	♀. Apical band and apical spots almost entirely red—a well-marked intermediate.
		13. ,,	17. ,,	20. ,,	23 ♂. 18 ♀ normal, except one ♀ slightly speckled red on apical white spots.
		14. ,,	,,	21. ,,	
	Remainder ♂♂ and ♀♀ normal or died.				Total 34 ♂♂. 25 ♀♀.

C1*a*. "Dry Heat." 101° F. 3 days before emergence.

No.	Placed in.	Date.	Date of removal.	Date of emergence.	Remarks.
1	As above.	18. 11. 10	21. 11. 10	22. 11. 10	♀. Apical band snow white, broader, longer and much more circular than normal, in two specimens thickly covered with red scales. The two spots in black costal band in cell very distinct, the outer larger and whitish; normally these are bluish, or indicated by blue scaling.
2	"				♀. (as 1)
3	"				♀. (as 1)
4	"				♀. (as 1)
5	"				♂. Cripple. Two spots in cell.
6	"				♀. As above.
	Remainder about 40 normal or died.				

Explanation of Plate XLI.

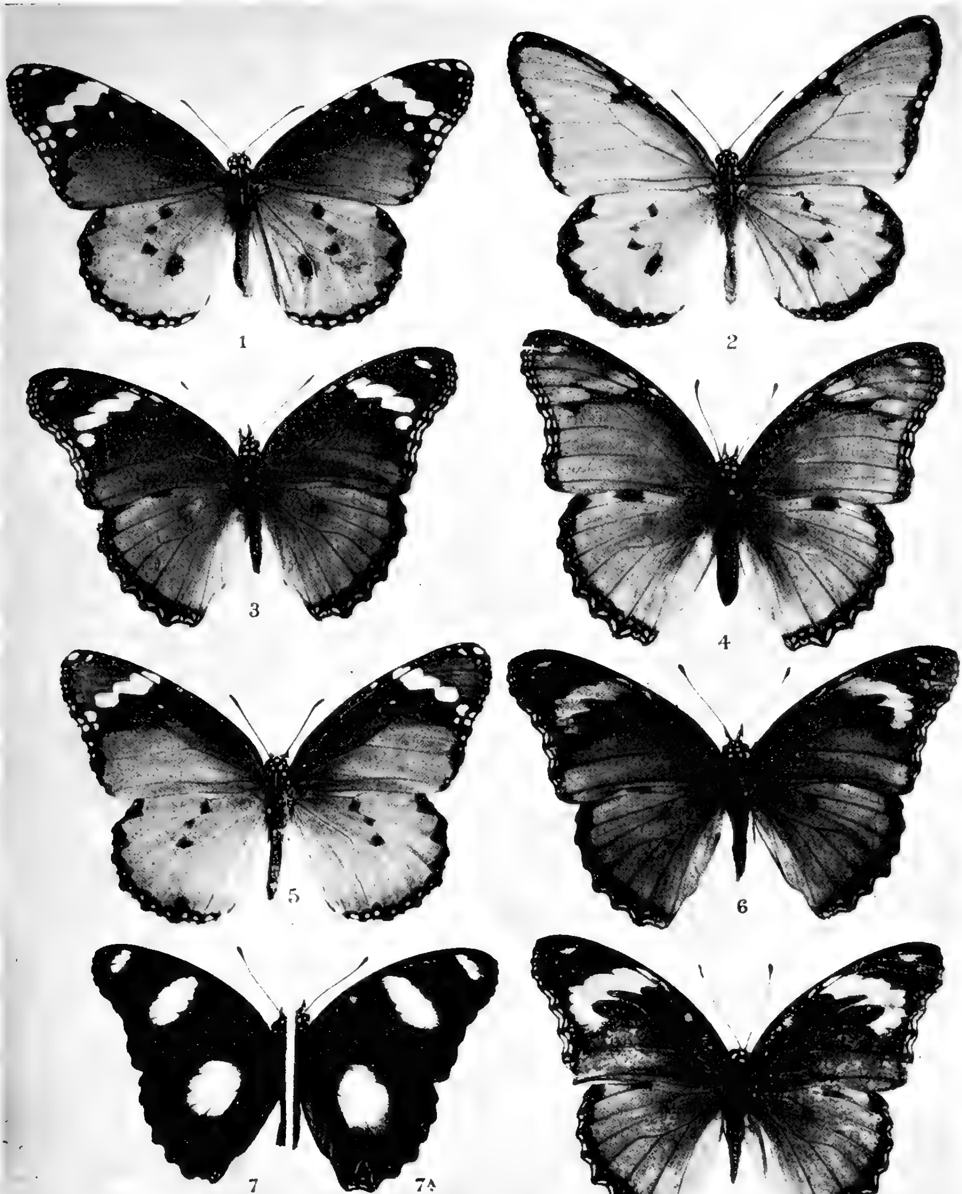
All the figures are about $\frac{3}{4}$ natural size.

Fig.

1. *Danais chrysippus*, ♂.
2. *D. chrysippus*, ♂ form *dorippus*.
3. *Hypolimnas misippus*, ♀ form *diocippus*.
4. *H. misippus*, ♀ form *inaria*.
5. *Danais chrysippus*, ♀, No. 87 intermediate.
   The apex of forewing is red, the white spots are diminished in size and the costa is lighter than normal.
6. *Hypolimnas misippus*, ♀, No. 19 intermediate, or reversion. The white subapical band and apex of forewing are thickly covered with red scales.
7. *Hypolimnas misippus*, ♂.

7*a*. *H. misippus*, ♂, No. 1, C 1.
   The specimen shows a white spot in cell of forewing, increased size of white spots in both wings with lunular band in hindwing. A reversion to older type?

8. *H. misippus*, ♀, No. 4, C 1*a*.
   The specimen shows an uninterrupted white lunular band and a white spot in cell of forewing; the apex is thickly covered with red scales. A reversion to older type?



Photo, A. Robinson. *C. Hentschel.*

DANAIS CHRYSIPPUS AND HYPOLIMNAS MISIPPUS

Exposed to heat in the pupal stage (Figs. 5, 6, 7a, 8) compared with examples bred under natural conditions (Figs. 1, 2, 3, 4, 7).

ON SOME UNINTENTIONAL EVIDENCE IN SUPPORT OF THE MIMICRY THEORIES, SUPPLIED BY A SMALL COLLECTION OF BORNEAN BUTTERFLIES.

By J. C. MOULTON, F.L.S., F.E.S.,

Curator of the Sarawak Museum.

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A collection of butterflies was recently brought to me for examination by a friend who had caught them all in a fortnight's visit to a Sarawak out-station (Simunjon, December, 1911); and as it demonstrates so beautifully some of the chief characteristics of an Eastern butterfly fauna, I have thought that perhaps a few notes may be of some interest. Museum collections give a general idea of the resources of a country in any particular faunistic branch, and entomological literature can tell us something about the habits and rarity (or otherwise) of each species, but a far clearer side-light on the subject is gained by examining a small collection of this sort, formed, I should add, by a non-entomological visitor, who was content to take the easy course of collecting all those individuals which for the most part seemed almost to court capture by their gentle flight and brilliant colouring. An entomologist, recognizing the common species, would probably have passed them by, and devoted his attention to the rarities. This collection, however, was made by a *non*-entomologist to whom all Sarawak butterflies were new and desirable, and hence, although there are no rarities which call for remark, the relative numbers of each species are both instructive and interesting.

Lastly I should add that my friend, in making the collection and in offering them to me for examination, had no idea that they were to be utilised for these notes.

The collection comprises 274 examples, representing 68 different species, no less than 108 specimens being divided among 5 species of *Danainæ*. The number of different species of butterflies at present known from Borneo is approximately 791. The following table shows the number of species known of each family together with the number of species and individuals obtained in this collection.

	Nymphalidæ.	Lemoniidæ.	Lycænidæ.	Pieridæ.	Papilionidæ.	Hesperiidæ.	Total.
Species known from Borneo ...	240	17	300	41	42	151	791
Species in collection ...	40	1	7	9*	9	2	68
Specimens in collection	197	1	9	25	40	2	274

The first point to notice is the relatively large number of *Nymphalidæ* obtained—no less than one-sixth of the total number known from Borneo—while over 71 per cent. of the specimens in the collection belong to this family.

If, furthermore, we analyse the *Nymphalidæ* so as to show the relative numbers of each group or sub-family, we obtain some significant figures.

	Danainæ						
	Danaini.	Euplœini.	Satyrinæ.	Elymniinæ.	Amathusiinæ.	Nymphalinæ.	Total.
Species known from Borneo ...	16	16	33	10	26	139	240
Species in collection	5	8	8	2	1	16	40
Specimens in collection	49	77	15	7	2	47	197

The very large proportion of *Danainæ* (*Danaini* and *Euplœini*) provides excellent evidence in support of the Müllerian theory of mimicry, which postulates associations or combinations of distasteful

* Not including one specimen as yet unidentified.

butterflies characterised by a common conspicuous warning pattern, which is further displayed and emphasized by large numbers of individuals and by a fearless, slow method of flight, so that they fall an easy prey to the net. In the Neotropical region the dominant Müllerian associations are formed by the *Ithomiinæ* and *Heliconiinæ*—butterflies characterized by a black and yellow striped, tiger-like, pattern. In the Oriental region these are replaced by two distasteful associations, each with its own particular mimics, (i) the black-and-white-lined *Danaini* and (ii) the black or iridescent purple-black *Euplœini*. This has been demonstrated often enough by writers who have studied European collections, but the involuntary evidence supplied by the above figures is to my mind even more eloquent.

The *Danaini* collected are chiefly confined to two species, *D. eryx*, Fab. (29 specimens), and *D. vulgaris*, Butl. (14 specimens). The other three species represented are *D. septentrionis*, Butl., 3 ; *D. lotis*, Cram., 2 ; *D. aspasia*, Fab., 1. Total 49 specimens. Of these only two females were noticed, both of *D. eryx*.

The *Euplœini* chiefly belong to three species, *E. claudius mulciber*, Cram., 27 ; *E. crameri*, Luc., 18 ; and *E. diocletianus lowei*, Moore, 20. The remaining species are *E. scudderi*, Moore, 2 ; *E. bremeri*, Feld., 4 ; *E. uniformis*, Moore, 4 ; *E. zonata*, Druce, 1 ; *E. corus butleri*, Moore, 1. Total 77. Of all these only one female was noticed (*E. claudius mulciber*).

The remaining species of *Nymphalidæ* call for little comment. They are:—

ELYMNIINÆ, *E. nigrescens*, Butl., 6 ; *E. panthera*, Fab., 1.

AMATHUSIINÆ, *A. phidippus*, Linn., 2.

SATYRINÆ, *Mycalesis medus*, W. M. et de Nic., 2 ; *M. anapita*, Moore, 3 ; *M. mineus*, Linn., 1 ; *Ypthima pandocus*, Moore, 1 ; *Y. fasciata*, Hew., 3 ; *Lethe europa*, Fab., 1 ; *Ragadia crisia*, Hübn., 3 ; *Erites elegans*, Butl., 1. Only one Lemoniid was captured, viz., *Abisara kausambi*, Feld., 1.

NYMPHALINÆ, *Neptis nata*, Moore, 1 ; *N. leucothoe matuta*, Hübn., 5 ; *N. peraka*, Butl., 1 ; *Junonia atlites*, Linn., 2 ; *Cethosia hypsea*, D. and H., 3 ; *Cynthia erota*, Fab., 15 ; *Cupha erymanthis lotis*, Sulz., 6 ; *Limenitis procris agnata*, Fruhst., 1 ; *Athyma kresna*, Moore, 3 ; *Adolias canescens*, Butl., 1 ; *Euthalia ambalika*, Moore, 1 ; *E. dunya*, D. and H., 1 ; *Eulepis delphis*, Doubl., 1 ; *Parthenos sylvia*, Cram., 5 ; *Cyrestis nivea nivalis*, Feld., 1 ; *C. theresæ*, de Nic., 1. Among the 15 *Cynthia erota* there was only a single female.

The *Lycænidæ* were conspicuously ill-represented—not a single example of the *Gerydinæ* or of the large sub-family of *Arhopalinæ* (of which some 60 species are known from Borneo). The 9 specimens captured are *Nacaduba ? atrata*, Horsf., 2 ; *N. ardates*, Moore, 1 ; *Lampides coruscans*, Moore, 1 ; *L. ? zebra*, Druce, 2 ; *Curetis thetys*, Drury, 1 ; *Biduanda thesmia*, Hew., 1 ; *Dacalana vidura*, Horsf., 1.

The *Pieridæ* captured are *Catophaga paulina*, Cram., 1 ; *Catopsilia crocale*, Cram., 5 ; *C. pyranthe*, Linn., 3 ; *Terias sari*, Horsf., 3 ; *T. hecabe*, Linn., 2 ; *T. tilaha*, Horsf., 2 ; *Leptosia xiphia*, Fab., 5 ; *Prioneris vollenhovei*, Wall., 1 ; *Huphina hespera*, Butl., 3.

The *Papilionidæ* are *P. helenus palawanicus*, Staud., 3 ; *P. nephelus saturnus*, Guér., 3 ; *P. memnon*, Linn., 6 ; *P. sarpedon*, Linn., 4; *P. evemon*, Boisd., 13 ; *P. eurypilus axion*, Feld., 4 ; *P. bathycles bathycloides*, Honr., 3 ; *P. agamemnon*, Linn., 3, and the Euplœine mimic, *P. caunus mendax*, Rothsch., 1.

There is a noticeable absence of the high-flying conspicuous *Ornithoptera* and *Troides*.

The swift-flying *Hesperiidæ* are represented by two specimens only, *Taractrocera ardonia*, Hew., 1, and one ? sp. very worn.

The collection brings out the following points :—

(i) *Euplœini* and *Danaini* are the most abundant, most easy to capture, and most conspicuous butterflies of the Oriental region, and therefore fulfil the requirements or answer to the definition of principal models in a Müllerian mimetic combination.

(ii) The Papilionine, *P. caunus mendax*, which so beautifully mimics the distasteful *Euplœa diocletianus lowei*, being taken together with that species, affords yet further corroboration of the statement that models and mimics are undoubtedly found together in the same place and at the same time.

(iii) In accordance with the theory of mimicry the distasteful models are numerically superior to their mimics. The collection shows 20 individuals of the model, *Euplœa diocletianus lowei*, to 1 of the mimic, *Papilio caunus mendax*, and none of the other two Bornean mimics, *Euripus halitherses* ♀ form *isa*, Moore (the Nymphaline), or *Mimeuplœa rhadamantha*, Butl. (Chalcosid moth).

(iv) The absence of *Lycænidæ* and *Hesperiidæ* in this collection demonstrates their capabilities for taking care of themselves, the former principally by protective colouring, and the latter by their swift flight, in addition to sombre colours.*

* It is also probable that more attention was devoted to the larger butterflies.—E. B. POULTON.

(v) The conspicuous absence of females supports another conclusion which follows from the mimicry theories, namely that females are more important than males for the continuation of the species, and that natural selection has evolved for them better means of protection, *viz.* (i) more sluggish habits, *e.g.*, females do not fly so much or appear in the open like the brightly coloured males which seem almost to court capture or the experimental tasting of young and inexperienced enemies; (ii) more perfect mimicry of some distasteful pattern or a closer resemblance to their surroundings.

Critics of the mimicry theories have often pointed out that it is easy enough to illustrate these theories with beautiful examples picked out from the collections of any large and important Museum, but they urge that it is quite a different thing to find such complete examples in real life. It is indeed true enough that one would have to sit in the jungle for many a long year before one managed to find in one spot and at one time a *complete* illustration of any one mimetic association, *i.e.*, like some of the remarkable series exhibited before the Entomological Society in recent years—series which show, *e.g.*, 100 examples of species A the dominant model, together with 50 each of the subsidiary distasteful models B and C, 10 each of the Müllerian mimics D and E, and one example each of the rare Batesian mimics F and G. I repeat that if one expects to see all the members of a combination like that alive in the tropics, the minute one finds a likely spot in the jungle, then disappointment awaits the visitor. But it is equally true that a supporter of the mimicry theory, if he diligently applied himself to it, *could* collect in one locality in a month or two, a very similar series to the picked exhibit which he had seen in London a few months before. And it is also true that a collector, with a bias *against* the mimicry theories, could make a numerous collection of common butterflies in this country, in which the Euplœine-Danaine element was not obviously dominant, and from which their rarer mimics might well be absent altogether.

I desire therefore to call attention once more to the value of a collection such as the one now described, since it was formed by one blissfully free of all views in support of, or antagonistic to, these theories. It is more instructive than any formed by a professional collector, who would have been at great pains to search out rarities and at the same time would have passed by the common species; it is also more valuable than the average collection formed by the amateur-visitor, because such collections usually contain too few specimens, or, if of larger size, have probably been augmented from the duplicate boxes of friends.

Professor Poulton has recorded instances of model and mimic being taken in one sweep of the net, and has even found model and mimic sent to him in one set of papers by a collector who, having taken the two in the same place and day, had not noticed that they were different species. I suggest that these scraps of independent and unintentional evidence in direct support of these theories are worthy of the serious consideration of those who regard mimicry as a museum-manufactured phantom, but non-existent as a real phenomenon in tropical life.

The following experiment made by Mr. Moulton, January 2nd, 1912, forms an interesting supplement to his paper:—

"I caught a male *Danais* (the specific name is illegible, but is probably intended for *eryx*) in my dining-room and gave it alive to a 'pig-tailed *Macacus*.' The monkey first held the butterfly by the folded wings, then opened the wings and pulled off the abdomen, which he smelt, pulled to pieces, smelt again, tasted, and threw down in evident and unmistakeable disgust. At the same time he liberated the butterfly which he had been holding with the other hand. The Danaine immediately flew away apparently uninjured, except for the *trifling* loss of its abdomen! I watched it for quite a minute as it mounted high up into the air, and, after hovering and gliding for some little time, flew easily away out of sight into a patch of jungle near by. The experiment showed not only the extreme distastefulness of the Danaine, but that the unpleasant quality resides in the body and has nothing to do with the pigment or the wings, as has been sometimes suggested. It also proved the extraordinary tenacity of life which is associated with the special means of protection."

The Sarawak Museum, Kuching:

December, 1911.

VI. *Experiments in* 1909 *and* 1910 *upon the colour-relation between lepidopterous larvae and pupae and their surroundings.* By ELIZABETH BRIDGES. Communicated by Prof. E. B. POULTON, D.Sc., M.A., F.R.S., etc.

[Read November 2nd, 1910.]

I. *Experiments on the larva of* U. sambucaria.

The following experiments were undertaken with the object of finding out to what extent the close resemblance of certain lepidopterous larvae to their surroundings is due to the adaptive power of the individual. Prof. Poulton * has already shown that several species (notably *R. crataegata, A. betularia, O. bidentata, G. quercifolia,* etc.) do possess in a remarkable degree the power of assuming the colour of their surroundings, and in the summer of 1909 he kindly gave me some eggs of *Sambucaria,* and suggested that I should test this species in the same way. The results of the experiments show that it is one of the most sensitive hitherto investigated. I will briefly describe the experiments, before giving the details in tabular form.

As is well known, the larvae of most Geometers feed only at night, and spend the day motionless in a twig-like attitude on the woody part of the food-plant, which in many cases they closely resemble. Prof. Poulton found

* Trans. Ent. Soc. Lond., October 5, 1903, and December 1892; and "Colours of Animals," Lond., 1890, pp. 111, 112.

that the larvae are only influenced by the colour of the twigs on which they rest, or of those quite close to them, and in the experiments here recorded, all were kept alike in clear glass cases with white roof and floor, the only difference being in the colour of the few sticks placed among the leaves of the food-plant.

The eggs, about 130 in number, were all laid by the same moth, and hatched between August 14 and 16, 1909. They were introduced into the different environments within a few hours of hatching. The environments were as follows:—

A. Slips of white wood painted crimson with water-colour.

B. Black twigs of birch.

C. Slips of white wood. (The wood not a dead white, but the cream colour of common deal.)

D. White wood painted a pale green with water-colour.

E. Dead sticks of oak covered with grey lichen and green powdery alga.

The food-plant employed was elder (*Sambucus nigra*). The larvae proved to have only various shades of black, brown and cream at their command. On the pale green sticks (D), they became cream-coloured, on the red (A), a reddish-brown; on the lichen-covered sticks (E) no lichen-like markings appeared as in the experiment on *bidentata* (see p. 144), but the larvae became a rich black of the same colour as the bark, and were most inconspicuous. Their sensitiveness showed itself rather in the swiftness and completeness with which they adapted themselves to the black and white environments (B and C). On the first day (August 21) that any were noticed on the black sticks, four became black on the back (they were distinctly darker than any of the other sets), and three days after this all but two were completely adapted, *i.e.* were indistinguishable in colour from the sticks. Those on the white sticks took some time to get rid of all traces of their dark markings: the first signs of the "bleached" appearance were not noticed until 12 days after they began to use the sticks (September 2): all but one were adapted in 21 days (on September 11). Notes were taken every three days with the exception of the first week. Those between September 29 and October 11 are omitted as no change was then recorded.

TABLE I.

DATE IN 1909.	A. PAINTED CRIMSON STICKS.	B. BLACK TWIGS OF BIRCH.	C. WHITE WOOD STICKS.	D. PAINTED GREEN STICKS.	E. DEAD STICKS OF OAK.
Aug. 14, 15, and 16.	About 130 hatched and introduced in a few hours. (About 25 in each set.)				
Aug. 18.	All on leaves.				
Aug. 21.	4 on sticks. 4 on glass, 1 of these bluish. 13 on leaves, 5 of these bluish.	5 on sticks. 22 on leaves, 4 of these bluish black on back. 5 faintly bluish.	5 on sticks, 4 on glass, 13 on leaves (9 faintly bluish).	7 faintly bluish. All on leaves.	5 on sticks, 3 bluish. 1 on glass. 16 on leaves, 7 bluish.
Aug. 24.	All on leaves. 4 light brown on back, 10 dark bluish on back. 5 intermediate.	2 on sticks quite black on back: black marks on brown underneath. 26 on leaves the same. 2 more on leaves brown on back.	26 all on leaves, 7 light brown on back, and dark bluish as in A, 11 intermediate.	All on leaves. 2 pale brown, 14 dark, 1 intermediate bluish.	All on leaves. 4 light, 1 intermediate, 17 dark.
Aug. 27.	All on leaves. 17 dark form, 2 light. These and 2 dark ones rather shorter than the others.	6 on sticks, 20 on leaves, 2 on ground. All in 2nd stage but 1. All but this 1 light brown underneath with reddish black marks.	17 2nd stage, dark form on leaves. Underneath greenish, with light brown markings.	All on leaves. 1 on stick 2nd stage dark form, 1 rather browner underneath than the others. 15 2nd stage on leaves, usual dark form as C. 1 1st stage, lightest form.	19 2nd stage usual dark form (6 rather browner underneath), 2 smaller (1st stage?) dark form.

Aug. 30.	All on leaves dark form, shiny reddish black on back, like B, but not quite so dark especially underneath, 19 counted. All 2nd stage.	2 on sticks, 2 on ground. Colour as before, but distinctly shiny on back like sticks. All 2nd stage.	9 on sticks, 14 on leaves, 1 on ground. Colour all as before. Compared with B, back bluer and not quite so dark or shiny. Dark marks underneath faint, except 1 on each side about middle segment.	2 on sticks, 1 nearly as dark as B. 15 on leaves, all as C.	1 on stick, as dark as B. Those on leaves as C, except 6, which are as dark as B and brown underneath.
Sept. 2.	All on leaves. 19 counted. 16 normal dark form as before, 3 more bluish on back, not at all shiny, but with very delicate white-lined pattern.	5 on sticks. Colour not noted in detail, but generally as dark as sticks.	12 on sticks. In 5 of these the marks underneath very faint indeed, in 2 quite gone. 10 on leaves, 2 with fairly distinct marks, 7 with faint marks, 1 with none. Backs shiny and fairly dark as before. 1 much lighter with a bleached appearance, bluish and showing the white lines distinctly. 1 on glass, faint undermarks and normal dark back. 2 on ground, 1 on roof the same.	5 on sticks, rest on leaves. Colour as before. 1 quite as dark as B.	2 on sticks. Rest on leaves, but 1 on glass. Not quite so dark as B, especially underneath.
Sept. 5.	4 on sticks, 1 on glass. 14 unshiny white-lined form as before. 5 shiny as before.	8 on sticks. 7 unshiny white-lined, 1 shiny. Rest on leaves, all unshiny but 1. 8 very dark brown underneath, 9 lighter, 10 intermediate.	10 still fairly dark and shiny on back. The rest (12) with the white pattern and much fainter darkness (the back almost same "value" as underneath). All on leaves but 1 on roof. Undermarkings very faint.	1 on roof, shiny dark back as before. 5 on leaves, unshiny white-lined form. Rest on leaves, shiny as before.	1 on sticks, shiny as before. 8 on sticks, unshiny white-lined. 6 on leaves, unshiny white-lined.

TABLE I (*continued*).

DATE IN 1909.	A. PAINTED CRIMSON STICKS.	B. BLACK TWIGS OF BIRCH.	C. WHITE WOOD STICKS.	D. PAINTED GREEN STICKS.	E. DEAD STICKS OF OAK.
Sept. 8.	1 on glass, 5 on sticks. 13 on leaves. Only 1 shiny. All more or less brown underneath (some a rich reddish brown).	10 on sticks. All very dark white-lined form, rich reddish brown underneath.	8 on sticks. Underneath creamy, nearly as light as sticks, with very faint marks. 2 still dark and shiny on back, the rest decidedly "bleached" looking. In 2 the darkness has almost vanished, and the back is a fairly uniform pale bluish colour. On leaves: 1 still shiny, 9 bleached, 5 quite light.	2 on roof, 11 on sticks, 3 on leaves. All fairly dark, white-lined form, brown marks underneath.	5 on sticks, rest on leaves. All dark, white-lined on back and rich brown underneath.
Sept. 11.	11 on sticks. 1 on glass. 6 on leaves. All as B, but not quite so dark.	14 on sticks. Rest on leaves. Colour as before.	11 on sticks. 10 on leaves. 1 on glass. 1 small one on leaves still dark on back. In the rest, the dark marks have almost gone, leaving the body of a dirty cream colour all over.	9 on sticks. 1 on roof. Rest on leaves. 1 on leaves still shining. The rest as before.	4 on sticks. 1 on glass. Colour as before.
Sept. 14.	1 on sticks. 17 on leaves. Colour as before.	1 on roof. 1 on glass. 13 on sticks. Rest on leaves. Colour as before.	15 on sticks. 6 on leaves. 1 on glass. 9 of those on sticks and 5 on leaves still have faint traces of marks near head. In 6 on sticks these are very faint. 1 on leaves still dark.	15 on sticks. 3 on leaves. In 12 the backs are decidedly "bleached" looking. (4 of these as light as the darkest in C.)	4 on sticks. 1 on glass. Colour as before.

Sept. 17.	9 on sticks. 8 on leaves. The backs of some are getting "bleached."	18 on sticks. Colour as before.	15 on sticks. 4 have traces still on 3 segments. In the rest only on 2. 5 on leaves. 1 small and dark. 2 with traces on 3 segments. 2 on 2 only.	14 on sticks. 4 on leaves. In 16 the backs are bleached, 8 are as light as the darkest in C.	Not noted.
Sept. 20.	7 on sticks. 5 have changed skin. 2 changing. 10 on leaves. All changed but 2. Colour as before.	20 on sticks. 4 changing. The rest changed. In all that have changed the back is reddish black with very delicate white lines. In all but 5 the marks are no longer continuous but isolated.	14 on sticks. 7 on leaves. 1 on glass. 7 changing. Mostly of a dirty cream colour all over, with very faint greyish marks. 2 of the changing ones and 1 of the changed have stronger traces near head. 1 on leaves still small and black.	6 on sticks. 5 changing, 1 changed. 11 on leaves, 8 changing. 1 changing on roof. Colour as before.	5 on sticks. Rest on leaves, but 1 on roof. 9 changing.
Sept. 23.	11 on sticks. 4 of these black on back with thin white marks. 7 rather bleached. 1 very much so. 5 on leaves. 3 black. 2 rather bleached.	23 on sticks. White marks all isolated.	17 on sticks. 16 dirty cream with faint marks, 3rd stage; 1 2nd stage with stronger traces near head. 1 on glass. 2 on roof. 3rd stage, very faint markings. 1 small one on leaves still dark and shiny.	Not noted.	Not noted.
Sept. 26.		23 on sticks. 1 on leaves.	20 on sticks. All dirty cream with very faint markings. 1 small dark one on leaves.		

TABLE I (*continued*).

DATE IN 1909.	A. PAINTED CRIMSON STICKS.	B. BLACK TWIGS OF BIRCH.	C. WHITE WOOD STICKS.	D. PAINTED GREEN STICKS.	E. DEAD STICKS OF OAK.
Sept. 29.	All but 2 on sticks. 8 reddish black as B. 6 rather bleached. 3 bleached nearly all over, not quite so light as C.	22 on sticks. The white lines very inconspicuous, being greyish or brownish. 2 on a black dead leaf, 1 of these very reddish. 1 on leaves, usual form.	20 on sticks, as before. The small dark one on leaves getting slightly bleached.	12 on sticks. 6 on leaves. Colour as C, but very slightly darker.	8 on sticks. 1 on glass. 1 on leaves: all dark and rather bleached on back.
Oct. 14.	4 on leaves. 12 on sticks. All dark as B, except 4, which are getting bleached and fawn-coloured.	As before. 1 more reddish than the others.	As before.	3 on leaves, rest on sticks. Colour as before.	3 on sticks, rest on leaves. Like B, but not quite so dark; very faint traces of green near tail in 2.
Nov. 11.	No change since Oct. 14. All the larvae arranged for hibernation, having refused food for several days.				
March 11, 1910.	The elder being still in bud, the larvae were offered some ivy. A little was eaten.				
March 15, 1910.	Fed with elder.				
April 27, 1910.	Brownish, with distinct purplish crimson traces on underneath and sides. All but 8 removed to avoid crowding.	All rich purplish brown. All but 15 removed for transference experiment.	All same tone as sticks, as before. All but 15 taken for transference experiment.	Slightly darker than C, but not at all green.	Colour as A, but darker and more streaky.
June 13, 1910.	All pupating.				

II. *Transference experiments.*

In order to find out to what extent the larvae were susceptible after hibernation, some were taken from the black surroundings in B, and given white sticks as in C. In the same way some were taken from C and put into a case containing black sticks. The results are best shown by a table. One curious point is that the white sticks produced their full effect sooner than the dark ones, whereas in the experiments on the early stages the reverse was the case.

TABLE II.

DATE IN 1910.	B^1 WHITE STICKS.	C^1 BLACK STICKS.
March 11.	8 introduced from B.	5 introduced from C.
April 27.	1 lightest form (as in C). 3 nearly light, as C. 1 slightly darker.	2 still as light as C. 1 of these small. 2 light pinkish brown. 2 smaller and rather darker.
April 28.	All but 1 as light as C. This one nearly so.	
April 30.	*Returned to black sticks.*	All as before.
May 5.	4 still as light as C. 1 much darker.	
June 13.	No change. All pupating.	All pupating.

III. *Experiments on the pupa of* U. sambucaria.

When the first of the larvae used on the previous experiments began to spin, all were arranged in various environments with a view to testing the susceptibility of the pupae. In the first set (Table III) the larvae were left in the same environments that they had hitherto occupied. The results of this set show clearly enough that when the same conditions are continued, the pupae are as well adapted to them as were the larvae. What they do not show is to what period of susceptibility the adjustment is due. Prof. Poulton thinks that it is effected just before pupation, and independently of the previous environment of the larvae. The results shown in Table

IV point to an opposite conclusion. The larvae in this set were those used in the transference experiments: in the table I have repeated the results of B (Table III) for comparison.

In the third set, the larvae were placed during pupation in compartments lined with variously-coloured papers and leaves. The results, so far as they go, seem to show that the pupae *have* a considerable power of adaptation, but as in this set I omitted to note the previous history of the larvae (they were taken at random from various environments), there is no real evidence of the extent to which the pupal colours are independent of the larval. I hope to repeat this experiment with more success next year.

TABLE III.

RECEPTACLE.	COLOUR OF PUPAE AND COCOONS.
A. (Crimson sticks).	2 with no cocoon. 1 darkest form as B, 1 rather lighter. 2 cocoon of old skins, etc. 1 darkest form, 1 rather lighter.
B. (Black sticks).	8 hardly any cocoon. Dark brown, smoked with black (Figs. 1, 1*a*). 3 cocoon of bits of leaf. Same colour.
C. (White sticks).	6 hardly any cocoon. Cream-coloured with rather sparing smoky specks and streaks. 2 rather more profusely speckled. 1 in cocoon of skins, etc., like these (Figs. 2, 2*a*).
D. (Pale green sticks).	1 slight cocoon, strong ochreous tinge with slight black marks. 1 slight cocoon, darkest form.
E. (Dark lichen-covered sticks).	3 no cocoon, darkest form. 2 cocoons of bits of bark, same colour.

IV. *Note on some experiments on* O. bidentata.

In the summer of 1909 I experimented with about 20 *bidentata* larvae given to me by Prof. Poulton. The results are not worth giving in detail, as the forms produced were exactly the same as those already obtained and described by him.*

* Trans. Ent. Soc. Lond., October 5, 1903.

They were as follows:—

(*a*) Black sticks painted to a dark crimson produced bluish-black larvae.

(*b*) Brown sticks of sycamore painted with white rings

1.

1*a*.

2.

2*a*.

3.

3*a*.

about 3 mm. wide, and the same distance apart; cream-coloured larvae with smoky markings on back.

(*c*) Dark twigs of larch with patches of grey lichen: very dark larvae with green and white lichen-like pattern.

(*d*) Slips of cream-coloured wood: cream-coloured larvae with slight smoky pattern.

(*e*) Purplish-black twigs of birch: bluish-black larvae.

(*f*) Black twigs of oak with pink spots painted on them: bluish-black larvae.

(*g*) Slips of white wood painted with scarlet squares (length of side about 2 mm.): cream-coloured larvae with faint smoky pattern (slightly darker than in (*d*)).

It will be noticed that the twigs painted in geometrical patterns produced no corresponding effect. The results of all the experiments seem to show that although the individual larvae and pupae are able to conceal themselves very effectually among surroundings to which the species is accustomed, they are powerless to effect any appropriate adaptation to an "artificial" environment.

TABLE IV.

ENVIRONMENT OF LARVAE FROM HATCHING UNTIL AFTER HIBERNATION (AUG. 1909 TO MAR. 1910).	MAR. AND AP., 1910.	MAY AND JUNE TILL ABOUT 6 HOURS BEFORE PUPATION.	ENVIRONMENT FOR 6 HRS. BEFORE PUPATION.	PUPAL COLOURS PRODUCED.
Black.	Bl.	Bl.	Bl.	8 with not much cocoon, 3 in cocoon of bits of leaf. All very dark brown smoked with black.
Black.	Bl.	Wh.	Bl.	2 in cocoons of leaf, slightly less smoky than the last set.
Black.	Bl.	Wh.	Bl.	2 no cocoon, 2 in leaf cocoons. These 4 of a uniform light reddish brown with very sparing black specks. 1 in leaf cocoon, darkest form.

V. *Notes on the apparatus used.*

The larvae were kept in clear glass cylinders or lamp shades, varying from 8 to 10 inches in height, and from 3 to 5 in diameter. The tops were covered by white muslin or calico. The floors were of wood covered with white paper: a hole in each floor allowed the stems of the food-plant to pass through into a jar of water. As the larvae became larger, some were transferred to other cylinders, so that they were never crowded.

The pupae which were not left in their original environments were tested in cardboard compartments (about

3 in. deep by 1 in. wide) with glass fronts, at an angle of about 45°. Both larvae and pupae were kept in a strong north light.

The hut in which the experiments were carried out was roofed with iron, and was generally a good deal warmer than the outside air. This probably had the effect of hurrying on the stages, for the larvae never attained a greater length than about $1\frac{1}{2}$ in.

TABLE V.

RECEPTACLE.	COCOON, IF ANY.	PUPAL COLOURS.
Black.	Scanty.	1 light reddish brown, 3 very dark.
Dark green.	3 cocoons of variously-coloured paper and leaf.	Darkest form.
White paper.	2 cocoons of paper and leaf.	1 darkest form, 1 greyish.
White calico.	1 cocoon of white threads.	Lightest form (cream-coloured).
Bark and grey lichen.	2 cocoons of bits of paper, etc.	Fairly dark.
Dead oak leaves.	1 cocoon of leaves.	Exact colour of leaves (Fig. 3, 3*a*).

XIV. *The Colour-groups of the* Hawaiian Wasps, *etc.* By R. C. L. PERKINS, D.Sc., M.A., Jesus College, Oxford.

[Read October 16th, 1912.]

[IN the autumn of 1911 I had the opportunity of discussing the subject of this memoir with Dr. Perkins during a too brief visit paid by him to Oxford. The discussion, thus begun, was continued with some energy on both sides, in a correspondence which only ended when Dr. Perkins sailed for Honolulu in November 1911. In the course of our correspondence he sent me a manuscript note-book, written about 1907–8, as part of his Introduction to the ' Fauna Hawaiiensis," now in the press. The facts and inferences concerning the present condition and past history of these Colour-groups seemed to me of such fundamental importance in the study of mimicry and indeed of evolution, that it appeared most desirable to publish the supplementary information and the further conclusions scattered through the letters. Dr. Perkins consented, and the following paper is the result. In order to understand the nature of the discussion, it has been necessary to quote passages and sometimes consecutive paragraphs from the note-book which will soon be published as the Introduction. For this free use of the manuscript I received the kind consent of Dr. David Sharp, F.R.S., Editor of the "Fauna Hawaiiensis." It must be clearly understood that the quotations are from the manuscript and not from the printed pages of the Introduction itself, and that some slight difference between the two accounts is to be looked for, owing to Dr. Perkins' final revision for the press. I have limited these quotations to the minimum quantity necessary to preserve continuity and to explain the letters, bearing in mind the inconvenience of printing the same passages twice over in two publications. No quotations from the note-book appear later than page 690, and in all the earlier part of the paper, where they occupy a large proportion of the pages, they are clearly discriminated from passages extracted from the letters, the latter being

between inverted commas and dated. I have not necessarily kept the extracts from the note-book in their original order and have ventured to condense certain parts. Beyond the point where extracts from the note-book cease, the quotations from the correspondence are no longer placed between quotation marks and are dated at the head instead of at the foot as in the earlier parts of the paper. In the concluding pages the passages are grouped under three separate heads. The few slight additions of my own are placed between the square brackets. Species quoted without an author's name were described by Dr. Perkins himself.—E. B. POULTON.]

EUMENIDAE.

[This family is considered first because of the number of the Hawaiian species and the dominant position taken by them in the Colour-groups of these islands.]

The whole of the species, to the number of 102, belong to the almost ubiquitous genus *Odynerus*, *sensu latiori*. From this interesting complex I have split off three small groups of species and considered them as distinct genera, as indeed they are, although they appear to be derivations of the same stock as the Hawaiian *Odynerus* proper. The Hawaiian Eumenids are, I now think, clearly descendants of two quite distinct forms of original immigrants, one of which, a yellow-banded form, gave rise to the bulk of the species, as well as to the endemic genera that I have separated from these, while the other has produced but four distinct species, as at present discovered, viz. *O. nigripennis*, Holmgr., and its three allies. This little group has now been traced to an Asiatic ancestor which is, I suspect, an ancient or primitive type, showing some affinity to the genus *Rhynchium*, in which *nigripennis* itself was originally placed by Holmgren.

"I have not yet identified the Oriental species (just lately discovered while mounting some insects) that is allied to the *O. nigripennis* group. It is the closest approach I know to the genus *Rhynchium*, but it is not that genus." *Nov. 13th, 1911.*

Species of *Odynerus* are almost ubiquitous throughout the islands, though some of the densest and wettest boggy forests are absolutely devoid of them. At the same time a slight change in these, made by the incursion of cattle,

is sufficient to allow of some species becoming established where previously they could not exist.

"Practically speaking, the cattle open up the dense forest, letting in sunlight and making it much drier. It is remarkable that no species of *Odynerus* should have been able to enter our densest and wettest virgin forests, because it would have found there such a vast store of (Lepidopterous) food, without other species to compete with it. Some of the bees have occupied such forests, in spite of the sun-loving habits of the group." *Nov. 13th, 1911.*

The prey of Hawaiian Eumenidae, so far as is known, consists entirely of caterpillars. On the whole it may be said that Pyralid and Microlepidopterous caterpillars are the favourite prey and that Geometridae are rarely utilised. It is most remarkable, seeing that the latter are occasionally taken (e. g. by *O. montanus*, Sm., *eucharis*, etc.), that this should occur so rarely, for the Geometrid caterpillars are so very numerous that they could be often obtained in any quantity.

In many localities at favourable seasons the number of individuals that are seen is extraordinary. On one occasion I visited a mountain gulch on Molokai nearly every day for three weeks, and I estimated that in a length of a couple of miles (below the line of forest) the population of adult wasps was at least one million. Five or six species were represented, but two or three were much more numerous than the others. I have noticed an almost similar abundance in other localities. It is probable that very few of the large number of species are really rare.

With experience and close attention in the field, it is fairly easy to discriminate between species that are exactly alike superficially, owing to indescribable differences in appearance, due to mode of flight and posture.

Only in exceptional cases do the Hawaiian Eumenidae exhibit important variation, and in very few cases is this more than of a trifling character, affecting the colour. A common variation, which occurs again and again and in the most diverse species, is the occasional assumption of a feeble yellow band or traces of such a band on the first and second abdominal segments in species which typically have an entirely black body. Examples of this are *Nesodynerus rudolphi*, Dalla Torre, *Odynerus venator*, and *O. heterochromus*, to instance only species very widely

separated in structure. Sometimes the yellow band appears only on the *ventral* surface. The phenomena are precisely identical with those observed in the *Crabronidae* (see p. 688), and, I think, are explicable in the same way. The blackness of so many Hawaiian Eumenids has been produced in the islands and the abnormal individuals are reversions to a former general condition in colouring. The Eumenids, furthermore, like the Crabronids, have retained in some species the original yellow-banded coloration.

The general tendency to blackness of the Hawaiian Aculeata, as a whole, is one of their most remarkable features. The blackness of these insects is increased by the dark colour of their wings, which, in a large number of the species, exhibits striking blue or purple reflections.

"My original paper * on colour of Hawaiian wasps was written too early to have much value. I treated only the Kauai species as conspicuous on account of the pale bands. This was an error; all the things I send as examples are conspicuous in life: they are *the* conspicuous feature among the day-flying insects in the islands and about the only one, except at special times and places." *Nov. 8th, 1911.*

The following Colour-groups—entirely different from the groups based on structure and real affinity—are distinguished in the Introduction.

On Kauai are two Colour-groups, one of which contains only two known species.

Group I. Insects with much red marking, wings shining fuscous, when spread.

O. blackburni, Kirb., and *soror*: allied species.

Group II. Black insects with two conspicuous whitish or yellow bands † on abdomen; wings dark and with conspicuous blue or purple reflections. Fourteen species of diverse structure.

"Kauai is the most northern of the forest-bearing islands, and it has by far the widest channel between it and its next neighour—Oahu. The specific characters of its species are usually the most striking of those exhibited on any island, but it lacks representatives of many 'groups'

* Proc. Phil. Soc. Cambridge, vol. ix, Pt. VII (1897), p. 378. The examples alluded to were exhibited to the Entomological Society, May 1st, 1912 (Proceedings, pp. lvi–lxv).

† "When the insects are on the wing, these bands are clearly seen."—R. C. L. Perkins, in Proc. Phil. Soc. Cambridge, vol. ix, Pt. VII (1897), p. 378.

of species in big genera. We have found no representative so far of *Chelodynerus*, none of the '*nautarum*,' de Sauss., group of *Odynerus* (probably one of the most ancestral), and it has no peculiar structural group, so that probably the groups of *Odynerus* in the islands were already formed before the genus chanced to reach Kauai, and some have not yet reached it. This is likely to be the case from a consideration of the beetles; for the Carabid *Cyclothorax* (s. l.), now split into several genera, is unknown on Kauai, very poor on Oahu, the next island, very rich on the intermediate islands, and rather rich on Hawaii at the other extremity. This fact alone, without appealing to the geological reasons, is sufficient to disprove Lord Walsingham's conclusion that the islands were once a larger *continuous land-area.* (See also p. 697.)" *Nov. 15th, 1911.*

In Oahu are four Colour-groups, two of which (II and III) may be said to be peculiar to this island.

Group I. Black insects with dark wings, showing conspicuous blue or purple reflections.

O. nigripennis, Holmgr., *epipseustes, erro, iopteryx, montanus*, Sm., *konanus, unicus; Nesodynerus optabilis* and *rudolphi*, Dalla Torre.

Group II. Generally small species, black with shining fuscous wings: no blue reflections. In this group some species show feeble and variable pale abdominal bands, and others some red markings apparently tending to disappearance, and not conspicuous.

O. dubiosus, Sm., *threnodes, pterophaennes, waianaeanus, paludicola, paranaias; Nesodynerus oblitus* and *acyanus.*

"The differences between species of the same genus which enter different Colour-groups are well seen in *Nesodynerus.* Thus *N. rudolphi* (I) is very common and ubiquitous, frequenting both forest and open country, while *N. oblitus* (II) is also abundant, but only occurs in localities—never forests—in which the very common species of *Odynerus*, viz. *dubiosus*, etc. (II), are found." *Nov. 15th, 1911.*

Group III. Insects usually much marked with red, and the body with appressed fuscous tomentum. Wings to a large extent hyaline and with no blue reflections.

O. pseudochromus, pseudochromoides, leiodemas, homoeophanes, eucharis, oahuensis, Dalla Torre.

On one occasion all the six members of this group were taken in the same spot and on the same day.

"The species fall into three very distinct structural groups:—(1) *O. oahuensis*: isolated structurally and in habits: common in all suitable localities, but less so than *O. pseudochromus*: affinity with other Hawaiian *Odynerus* is not clear, but requires far more study; (2) *O. pseudochromus, pseudochromoides, leiodemas*: allied species, the first two ubiquitous and common in their proper localities: the third is probably generally to be found with them, but is much less numerous; (3) *O. eucharis, homoeophanes*: allied species, of which one is found with species of the structural group (2) in some localities, the other with them in other localities. They are probably always relatively rare." *Nov. 15th, 1911.*

Group IV. Insects with usually two pale abdominal bands, the wings more or less infuscate and with blue reflections, body generally with pale tomentum.

O. xerophilus, nautarum, de Sauss., *acoelogaster*; *Pseudopterocheilus relictus.**

* [I was particularly anxious to see the members of Colour-groups which had been captured at the same time and place, in order to be able to estimate the relative numbers and obtain conclusive evidence as to the predominant species. Dr. Perkins very kindly collected for me on three occasions the specimens which are tabulated in the following extract from his letter, written May 20th, 1912, from Honolulu. The captures of each date are kept together in the Hope Department, where they may be studied at any time. They were exhibited, in illustration of Dr. Perkins' paper, at the Second Entomological Congress at Oxford during the past summer.]

I have been out in the country on three occasions lately to catch *Odynerus*, and had Kershaw to help me. It is a bad season on the lowlands, as we have had no winter rains and the country most favourable for Hymenoptera is parched up. It is interesting to see what is dominant under these conditions.

On the first day (April 26th, 1912, Makiki, Oahu, below 400 ft.) caught only one species, *O. nigripennis* (38 specimens), but I saw one individual either of *Nesodynerus rudolphi* or *Od. montanus*.

On the second day (May 3rd, lowlands near coast, east of Honolulu) we caught of the same all-black, blue-winged Group I:—

O. nigripennis (21) *O. montanus* (1) *O. iopteryx* (2) *Nesodynerus rudolphi* (6)	3 structural groups in these 4 species !

Of the white-banded Group IV:—
O. acoelogaster (10).
O. nautarum (1).
Ps. relictus (1).

On Maui, Molokai and Lanai, the fauna of each of which is largely the same, we have three groups :—

Group I. Identical with I on Oahu.

O. nigripennis, Holmgr., *purpurifer, instabilis, ecostatus, laevisulcatus, camelinus, brevicostatus, aprepes, lanaiensis, konanus; Nesodynerus eupteryx, paractias; Pseudopterocheilus congruus*, Sm.; *Chelodynerus chelifer.*

Group II. Identical with IV on Oahu.

O. molokaiensis, sociabilis, smithii, Dalla Torre, *insulicola*, Blackb., *nubicola, nivicola.*

Of the small shining-fuscous winged Group II :—

O. dubiosus (7).
O. threnodes (3).
Nesoprosopis assimulans (2).

Had it been a good season, of I there would have been many more *montanus*, otherwise proportion as above.

Of IV we should have found *O. xerophilus* numerous locally and *Pseudopterocheilus relictus* abundant, otherwise proportion as we found above.

Of II we should have also found *Nesodynerus oblitus*, local, not general like the two above-named species of this group.

The third day (May 10th, Palolo) we collected at 1200–1500 ft. in forest.

Of the curious clear-winged Oahu Group III, with dull red marks we got only :—

O. pseudochromus (16).
O. oahuensis (3).

On a good day we might have found the closely allied *O. pseudochromoides* nearly as common as *pseudochromus*, with *one or two individuals* each of the three rare species, *O. eucharis, leiodemas*, and one other closely allied to *eucharis*, viz. *homoeophanes.* All these occur in the very spot where we collected.

Of Group I we got *O. rudolphi* (10), *O. nigripennis* (4), and *O. montanus* (1): also *Hylocrabro tumidoventris* (5), *Xenocrabro unicolor*, Sm. (1).

Group I was also represented by the Ichneumonid, *Echthromorpha fuscator (maculipennis*, Holmgr.) (5).

The little endemic flycatcher, *Chasiempis*, was fairly common, young and old, and as tame as usual, but was clearly not paying any attention to Hymenoptera. The chief interest to me of the whole collection is the evidence as to what species are most abundant under circumstances unfavourable for Hymenoptera. From long experience I know exactly what one would, or might expect to get under favourable circumstances.

Group III. Insects with red thoracic or abdominal markings, or both, the wings dark and with blue reflections.

O. frater, Dalla Torre, *monas, cephalostictus, naiadum, tempe, dryas, potamophilus, microdemas, monobius, erythrostactes, montivagus, sandwichensis,* de Sauss., *petrobius, deinogaster, homoeogaster.*

On Hawaii there is a general tendency of the above three groups to become fused into one large group, all representing I on Oahu, and on Maui, Molokai and Lanai. *O. obscurepunctatus,* Blackb., and *rubropustulatus,* Blackb., and one or two others may be recognised as obscure members of Group III, of Maui, etc. *O. newelli, sociabilis,* and *scoriaceus* represent II.*

Speaking generally of these groups, I find that in the field, the members of each are easily enough distinguished. There are, as might be expected, some cases of species that are intermediate in appearance and might be placed in either of two groups, but these are very few. On Kauai Group II stands out remarkably from all others, since nearly all the Kauai species belong to it, while it is only approached in appearance by a few species in Group IV on Oahu. The tendency of the species to become red-marked on the three intermediate islands (Maui, etc.) is very

* [At this point it is convenient to print Dr. Perkins' comments on the abstract of this paper and the lists of specimens sent by him for exhibition when it was read (Proceedings 1912, pp. lvi–lxv). Dr. Perkins arranged the specimens and wrote the lists in the midst of the preparations for his departure from this country, and he had no opportunity of revising the MSS. On his return to England he wrote, September 17, 1912, stating that my footnotes on pp. lviii, lix are correct, and that *N. pubescens*, var. in B (p. lviii), and *N. fuscipennis* in E (p. lix) should be transposed. He furthermore explained that the common typical *N. pubescens* placed in E (lix) does not in reality fit into any group on Hawaii. Dr. Perkins wrote :—

"I suppose I sent a specimen for comparison with the rare blue-winged form, which we should expect to be dominant, and if selective processes were going on now, would surely become so, this being a grand chance for natural selection to work upon. The rare variety is the one that fits the colour-scheme of Hawaii, the very abundant typical form does not."

Concerning *O. molokaiensis*, referred to in the footnote on p. lix, Dr. Perkins remarked that "the female never has bands and is a perfect representative of the dominant Colour-group (E = I). *O. molokaiensis* male may have two fairly good pale bands (as in II of Molokai, etc. = IV. of Oahu), or one may be entirely obliterated and the other faint."]

striking, nearly half the known species being so coloured. Group IV on Oahu (= II of Maui, etc.) is not very clearly marked off from its Group I, when the insects are seen in flight, but, as they usually have a characteristic grey or hoary appearance, they may be kept apart, especially as they represent species mostly peculiar to open country or open spaces in forest country. When their representatives on Hawaii are considered, they become much less distinct from those representing Group I on that island.

Groups II and III on Oahu are peculiar to itself, the dull red markings, clear wings and body clothing of the former giving them, dead or alive, an appearance unlike anything else, and the shining fuscous wings of the latter rendering these equally unmistakable.

In a few cases, isolated species have been found on islands, where they ill accord with the groups there represented, but one cannot overlook the probability of these being recent immigrants. Thus *O. frater*, Dalla Torre, a widely distributed species, has been found very rarely on Oahu, where it does not fit into any Colour-group, as it does on Maui, where it abounds. Excepting on Kauai, the Group I of Oahu is well represented on every island, besides tending to absorb all others on Hawaii, so that nearly half the known species of the wasps may be referred to it. The dominance of this group increases the blackness of our series, for it contains species almost or entirely black and with dark iridescent wings; and, when other groups of Hymenoptera are considered, is swelled by species of bees, of fossorial wasps, and even of parasitic Ichneumonoids.

"In these associations of Aculeates, the Eumenidae are probably dominant, although both the Fossores and bees are extremely ancient. In the Crabronidae several genera have been evolved probably from a single ancient immigrant species (see p. 688). Over fifty species of *Nesoprosopis* fall into structural groups of which one has become parasitic (inquiline) on the others and has lost the special pollen-sweeping apparatus on the front tarsi. Five of these inquiline species have been produced, of course from one original. The three most yellow-spotted species of *Crabro,* which always have a yellow-banded abdomen, are found on Kauai with the yellow-marked *Odyneri.* Two of these Crabros extend to the other islands, or some of the other islands, but one of these, on Oahu, is tending towards

black, while the female is sometimes entirely black. The yellow-banded Crabros on islands other than Kauai are generally found *in the open country* where the yellow-banded *Odyneri* occur." *November 15, 1911.*

It is clear that the colour phenomena exhibited by our Hawaiian Hymenoptera are similar to those seen in other countries (whether in the Hymenoptera or in other orders) where such colour groupings are explained as being associations of inedible species, which are easily recognised by predatory enemies from their similarity of colour. Whether this explanation is true of the Hawaiian case is I think very doubtful, though I do not doubt that a satisfactory explanation of the latter would also explain the others. The Australian Eumenidae, Prosopidae and Fossorial wasps furnish instances very similar to the Hawaiian, and in the same groups, as I have myself observed in the field, in that country.

If we assume that these Colour-groups are formed by processes of natural selection and are indicative of inedibility, we are perplexed as to the immunity of insignificant forms, which do not attain notably iridescent wings or other markings and yet fly round in company with the others and are equally or sometimes more plentiful.

"If the Müllerian theory be correct, *wing coloration* is of paramount importance in the Hawaiian groups. It appears to be very suggestive that most of the clear-winged species of bees and wasps are open-country insects. Of course many of the dark-blue iridescent-winged ones mix with these, but then they are also common in the woods too—I mean individuals of a single dark-winged species are common in both situations.

"There are (with reference to colour of wings) distinct evidences in some Hawaiian Crabronidae, of sexual selection being operative. This again, in connection with Müllerian grouping, might start another distinct line of investigation!" *November 13, 1911.*

The writer collected series of nearly every land-bird on each island and so was able to examine the stomach contents of a large number of birds in all, and the finding of but a single *Mimesa* (in the stomach of the thrush *Phaeornis lanaiensis*) would not tend to show the Hymenoptera, as a favourite food, in any shape or colour. As a matter of fact, an Aculeate Hymenopterous insect (with rare exceptions) is so unlike that of any other Order by its general appear-

ance in life, that one can hardly credit any vertebrate enemy with sense enough to distinguish between Colour-groups of these and without the sense to distinguish the class as a whole.

If Colour-groups in Hymenoptera have arisen as a mark of inedibility, the latter quality can I think have nothing to do with the possession of a sting.*

At one time † I supposed that the Hawaiian Colour-groups might be the result of the action of climatic differences, at least in so far as these groups were special to certain of the islands. This seems very doubtful, for we find the nearest approach to the Colour-group of wasps living in the forests of Kauai, in those living on the driest coasts of Oahu, and quite absent from its very similar forests. In fact a satisfactory explanation of the Colour-groups of Hawaiian Hymenoptera is wanting, and, when found, will no doubt explain some of the similar phenomena elsewhere.

It is interesting to trace the structurally allied forms on different islands and see how their superficial appearance is changed by entering different Colour-groups.

Odynerus eutretus of Hawaii is a black insect with dark-blue iridescent wings; on Maui, it is represented by *O. homoeogaster*, a red-marked wasp; on Kauai, by *O. mimus*, a conspicuously white-banded species. The *obscure-punctatus* group on Hawaii is replaced by the redder species *O. sandwichensis* and its allies on the intermediate islands; on Oahu, the blue iridescence of the wings is lost as well as all the red markings (*O. dubiosus* and allies), while on Kauai, the red markings remain, but the wings are of a shining fuscous (*O. blackburni* and *soror*), as in the Oahuan allies. *Odynerus nigripennis,* ubiquitous over all the other islands, is replaced on Kauai by the equally common, pale-banded *O. radula,* F.

PROSOPIDAE.—All the fifty-three species belong to the single genus *Nesoprosopis* based on the island forms but

* Compare Trans. Ent. Soc., 1904, pp. 645–6.—E. B. P.

† Dr. Perkins is evidently alluding to his paper in Proc. Phil. Soc. Cambridge, vol. ix, Pt. VII, 1897, p. 380, where he argued that the colours are due to "climate or some such cause." He also wrote, November 10, 1911, in reference to the above paragraph in the text:—

"I did not state other reasons against the 'climate' view because I hardly thought it worth considering—there are too many impossibilities in such a view!"

subsequently found to contain a European species, *Prosopis kriechbaumeri*, Först., and later a Chinese one. Thus an Asiatic origin is highly probable. The *Nesoprosopis* are almost the most ubiquitous of any Hawaiian insects.

CRABRONIDAE.—The Hawaiian Crabronidae are represented by eighteen described species, which I have distributed in four genera. All these forms appear to be closely allied, and, as it appears to me, might well be the descendants of one original immigrant yellow-spotted form, allied to the British *Crabro vagus*, L. To this latter there are closely allied species in China, if it does not occur there itself, and for this reason an Asiatic origin for the Hawaiian forms may be suspected. Of the eighteen species, three represent each one a distinct genus, while another genus, *Nesocrabro*, contains four species, so that the greater part of the known forms fall into one genus *Xenocrabro*, of which the others appear to be simply derivatives, and it is to the least remarkable of the Hawaiian species of *Xenocrabro* that the European *Crabro vagus* is most nearly related. None of the other diverse groups of Crabronidae are represented in the Hawaiian Islands.

Some of the species are much and conspicuously marked with yellow on all parts of the body, the yellow markings becoming reduced in others, until, in *X. mandibularis*, Sm., we have an entirely black insect. There is, in the yellow-marked species, much variety in the coloration, and the variation exhibited is often of an interesting character.

C. distinctus, described by Smith from a *Crabro* obtained from Hawaii early in the last century, was at first unknown to me, and I suspected a mistake in the locality. Later on, however, I found that Smith's species is an extreme and rare variety of *C. notostictus*, which is typically a black insect with small yellow thoracic markings. Intermediate specimens between the extremes are much commoner than typical *distinctus*. This brightly marked form has so far only been found at or near the coast, where the intermediate forms also occur, as well as the variety I called *notostictus*. In the mountains in the forest region the latter is predominant and intermediates are rarely met with. From these facts one might suspect that the hot dry climate of the coastal regions was productive of the conspicuously marked varieties. The following considerations make such an explanation improbable. In the genus *Nesocrabro* I

described a species, gaily marked with yellow as *N. bidecoratus*, adding a remark to the effect that "In spite of its extremely distinct appearance I suspect it may prove to be a variety of the following," viz. *N. rubrocaudatus*, Blackb., and Cam. ("Fauna Hawaiiensis," vol. i, Pt. I, Hymenopt. Acul., p. 27, 1899). This now proves to be the case, intermediate varieties having been secured. The variation in this case is even more extreme than in the other, since typical *rubrocaudatus* is an entirely black-bodied insect, whereas the variety *notostictus* of *distinctus* has at least yellow thoracic markings. It is interesting to observe that the markings of the most highly coloured *N. rubrocaudatus* (var. *bidecoratus*) almost entirely resemble those of *Xenocrabro distinctus*. Looking at the localities where these highly marked varieties of *Nesocrabro* occur, we find that, far from living in the hot and dry places, they are found in the wet woods near Kilauea (4,000 ft.), in the still wetter district of Olaa, and other localities of Windward Hawaii. I think that these highly coloured varieties are "reversions" to an ancestral style of coloration, and I believe this is borne out by an examination of the varieties of other Hawaiian species. In these there is a general tendency to blackness of coloration, some few retaining conspicuous yellow markings, while most have these reduced to inconspicuousness or they are entirely absent. *Xenocrabro hawaiiensis* and *fulvicrus*, *Oreocrabro abnormis*, Blackb. and Cam., and *Hylocrabro tumidoventris*, species with normally black abdomen, all become spotted as exceptional and sometimes very rare varieties. Species like *Nesocrabro stygius*, Kirb., and *daemonius*, with immaculate abdomen above, frequently retain yellow pigment spots beneath, where they are concealed from view. Generally speaking yellow markings, especially thoracic, are less easily lost in the female than in the male. The general blackness of the Hawaiian Crabronids, as now manifested, has I think been produced within the islands, and while some still retain more or less the colour of their ancestors the majority have greatly departed therefrom, though many of them in exceptional individuals reproduce that coloration to a greater or less extent. Further, a study of the case cited of *Nesocrabro rubrocaudatus* and *Xenocrabro distinctus* lends strong confirmation to the community of descent that is suggested by the consideration of their structural characters. At least I find it diffi-

cult to understand how two species of these distinct genera can under totally different conditions of climate and environment produce remarkable colour varieties, totally dissimilar from their usual forms, yet almost identical with each other, unless they be reversions to a former style of coloration.

[No further quotations from the Introduction will be found beyond this point, but it has been necessary in the preceding paragraphs to quote from it somewhat extensively, in order that the discussion in the following letters may become clear. After reading the statements reproduced above, I asked Dr. Perkins, among other questions bearing on a possible Müllerian interpretation of the facts, whether the reversion to an ancestral pattern—or more probably the persistence of an ancestral pattern—in the form *distinctus*, might not be associated with the presence of the pale-banded *Odyneri* which are also found in the open country. He replied, Nov. 15, 1911, as follows:—]

X. notostictus, the *black*-bodied form of *distinctus*, seems to be the only form in the forest region where are no pale banded *Odynerus*, except occasional reversional individuals. Typical *distinctus* of Smith is essentially an open country, sublittoral form, but the *notostictus* form may occur with it, and intermediates. There is a number of pale-banded *Odynerus*, belonging to this open country, or sublittoral, and only belonging to this country. Several species of the predominant black group of *Odynerus* are common both in this open country and forest alike. This would be very suggestive to the Müllerian.

The case of var. *bidecoratus* is quite different, for instead of being coastal, it inhabits very wet forest districts, mixed with the typical form but rarer, and probably less widely distributed. Before I knew this, I thought the pale marked Crabronid vars. might be produced by the dryness and heat of the coast region—they average smaller in size also: *bidecoratus* upsets this view.

Müllerians would say that '*notostictus*' persisted in the coastal regions because of the presence of the pale-banded *Odynerus* (or, at least, for the same reason that the latter do, viz. absence of enemies), and would cite the fact that all Crabronids on Kauai are yellow-banded, the black-bodied group of *Odynerus* being absent there. Obviously the colour of the var. *bidecoratus* is quite out of place in wet forests on Hawai, where are no yellow-banded *Odynerus*,

except rare varieties that have reverted to the ancestral pattern. No male form of *bidecoratus* has yet been found, the male *rubrocaudatus* only existing with these so far as is known, and this male is in perfect harmony with the *Odyneri* of the woods. On the Müllerian theory I should say that the more easily changed male of *rubrocaudatus* arrived at a very perfect and stable state of mimetic resemblance to the *Odyneri* of the woods, but that the more conservative female had never reached so perfect a condition—as shown also by its hyaline wings—and that, owing to its conservativeness, it had not reached the stable condition of the male abdominal colouring, when the causes leading to the mimicry (viz. bird attacks) were removed or much abated. I should look on it as a species of which the ancestrally coloured *bidecoratus* form might easily in future times become dominant again.

I have made a crude sketch of a *distinctus* female, from which you can judge how different it appears from an all-black-bodied *notostictus* var., and the brightest female *Nesocrabro rubrocaudatus bidecoratus* has almost a yellow abdomen, the black is so reduced.

[The accompanying drawing of the ♀ *X. distinctus* showed that the following structures and markings are yellow: the pronotal collar, a transverse spot on the scutellum and another on the post scutellum, a curiously shaped spot on the 1st abdominal segment, a band on the 2nd, 4th and 5th, a minute lateral spot on the 3rd, not really visible in a strictly dorsal view. The var. *notostictus* possesses the above-described thoracic markings, but is without the abdominal, although intermediates occur. Another drawing, of the basal abdominal segment of *Nesocrabro rubrocaudatus* var. *bidecoratus*, showed the similar character of the variable yellow spot to that of *X. distinctus*.

Dr. Perkins added:—]

The typical *rubrocaudatus* is entirely black, but in some examples the thorax may have the yellow markings of the var. *bidecoratus*, without any abdominal markings. If abdominal markings are present, thoracic ones are invariably developed.

[Concerning the tendency of the females to lose the white or yellow bands on the abdomen, Dr. Perkins wrote, Nov. 15, 1911:—]

In *Odynerus*, the species of the structural group of *O. sociabilis* and the group of *O. nautarum* have always

the bands more faint or altogether absent in the female. In the Crabronidae the females seem harder to shift from the normal, and I believe that this kind of 'conservatism' is really true of the female sex among insects in general. For instance, in *N. rubrocaudatus*, the male has characteristically dark wings with blue iridescence, but the female has clear wings. In many of the species, the male wings are darker than the female, as though it were hard for the latter to become changed, and this is the same with the thoracic spots, which in three species of *Nesocrabro* with black abdomen are altogether wanting or reduced in size in the male, while they are in two species always, or nearly always, present in the female, and in the third are present in some varieties. They seem to give up these characters with great difficulty.

I should think it much more probable on the Müllerian theory that 'the predominance of female mimicry in butterflies' is due to the necessity of a long life (for egg-laying) for the females, and not to 'a greater female variability in features associated secondarily with sex.'

On the Müllerian theory, I should say that the presence of numerous reversional examples in the Hawaiian species is likely to be due to the fact that nowadays the bird competition has become ineffective. These reversion colours, in *Odynerus* at least, are more often found in males than females; I should say because the females, having once arrived at a stable condition, are less easily changed, i. e. more 'conservative.' There is a war between the greater need to change in the female and the 'conservatism,' doubtless, in producing Colour-groups, just as sexual selection may cause interference. There is not the least doubt that in Hymenoptera generally, the males are of very transitory appearance compared with the females, the difference in length of life often being one of months.

Facts and Arguments for and against Müllerian Mimicry as the Interpretation of the Colour-groups of Hawaiian Aculeates.

[From this point the passages from Dr. Perkins' letters are grouped under heads.]

Nov. 8, 1911.

I have myself for years considered the Batesian theory

of little moment compared with Fritz Müller's: possibly all of Bates's examples are simple Müllerian ones.

Nov. 10, 1911.

I am unable to suggest any explanation whatever for the Colour-groups other than the Müllerian one; but I could not get any definite evidence that this is true. I have examined vast quantities of *young birds* in the islands—they are always present *at all seasons* owing to the equable climate, but what I have examined is nothing to the numbers I have watched at close quarters. Camping entirely alone, as I so often did in untrodden forests—for weeks together during some six years—where the birds had never seen a human being, the young were often so tame, they could even be knocked down with a switch! It was often impossible to shoot a bird, as they would come so close out of curiosity and one could not get away from them, especially young birds.

Nov. 14, 1911.

I should say the present-day Hawaiian birds are very well educated by the parents in the matter of choice of food. It was always a marvel to me why the parents should tend them so long. I have doubtless remarked on it often, but may here quote at random, from "Fauna Haw." I, p. 404, of that common species, *Vestiaria coccinea*, "the yellow, black-spotted young follow the parents sometimes till they are far advanced in their red (i. e. mature) plumage, but they very early learn to obtain nectar for themselves, even at a time when the parents are still feeding them on caterpillars." Again, p. 406, of *Palmeria*: "The young follow the parents often until they have arrived at almost their full plumage, and after they have acquired their full song, but in the winter months these companies are disbanded. In February and March they are generally paired."

I think similar remarks might be made on almost every insectivorous Hawaiian bird, certainly all the common ones. I noted even of the rare and extraordinary *Pseudonestor*, p. 432, "they are unwearying in supplying their *full-fledged* young with food, and when the latter are soliciting this from their parents they form a most comical group."

I do not think any one will ever again see Hawaiian

birds as I did from fifteen to twenty years ago. Some that I found commonly seem now quite extinct, and others greatly reduced in number. It would be almost impossible to duplicate the observations I then made.

Nov. 10, 1911.

What troubles me as to Hymenoptera is, that any bee or wasp in life is so utterly unlike anything else, that the veriest duffer of a bird can hardly mistake it for anything else, and it is clear that in the islands those which remain small in size with no colour of any sort (i. e. no pattern and ordinary wings) are not now eaten and are fully as successful as any belonging to the Colour-groups. Why then on one little island (Oahu) should a lot of species associate themselves in several Colour-groups for protective purposes? It would appear much more advantageous for all to belong to the dominant black-coloured blue-winged group on the one island, as one would say it would be much easier for birds only to have to learn one colour pattern than several. One tasting might do for the whole lot, if they were one colour, but a number of tastings might be necessary for a lot of groups; and then I come back to the old doubt, why is not the fact that all are characteristically Hymenopterous (whatever be the colour) sufficient in itself?

Nov. 15, 1911.

If birds can select between very slight colour variations so as to produce the closest mimetic resemblance, it seems strange that they should not recognise *any* Hymenopterous insect as such quite apart from colour and pattern. That they do recognise Hymenopterous characters other than colour, seems to be proved by a mimetic Australian *Mantispa*. Although superficially quite unlike a Hymenopterous insect, this *Mantispa* is, from its behaviour and attitude, a perfect mimic—in fact the best known to me. No Syrphid with all its wasp-like coloration can approach it.*

* The mimicry of *Mantispa* was observed by W. M. Wheeler in Nebraska (1888), G. A. K. Marshall in Natal (1896), and R. Shelford in Borneo (1898–1900) and Singapore (Trans. Ent. Soc., 1902, pp. 536–7; Proc. Zool. Soc., 1902, pp. 235–7). Both Marshall and Shelford speak of the excellence of the mimicry on the wing. At the same time Shelford's Plate (P. Z. S. 1902, XIX, figs. 22–7), and both his and Wheeler's descriptions show that colour may enter largely into the mimetic resemblance in certain species of *Mantispa*.—E. B. P.

Nov. 13, 1911.

If I could see the very ordinary-looking Hawaiian species —just like those one may see anywhere in the world—at the least disadvantage as compared with those of the special groups, I should have little doubt of the Müllerian theory—though I should still say that in our islands the groups were formed in the past, by causes no longer operative—but the insignificant forms, like many *Nesoprosopis*, are extraordinarily successful in life. Yet we have to admit that those coloured to fit special groups have originated from such forms. The general tendency for the latter to belong to open country and the changed condition of the Avifauna are *the points* that the Müllerian must lay the greatest stress on. I could make the case stronger for him by going into minute detail at considerable length. It would be quite easy to fill a volume with facts concerning these Hymenoptera, dealing with their variations, colours, structures, etc. The true affinities of the species, one to another, becomes very important, when considering the Colour-groups.

Nov. 10, 1911.

With the Hawaiian wasps (*Odynerus*) it must be remembered that, excluding one group of 4 species which are derived from some fairly ancient immigrant from Asia, all the rest are apparently the descendants of *a single very ancient immigrant species,* though by excessive evolutionary change the descendants have now formed distinct genera and structural groups within the islands. There is evidence for the conclusion that the original ancestor was black with yellow bands, such as one now sees all over the world. One must regard all these Colour-groups as having been formed (i. e. started) actually within the islands.

Conditions under which the Hawaiian Colour-groups may have arisen.

Nov. 10, 1911.

If the Müllerian theory is the right one in this case, I am sure that we must look back to a long past time for the formation of the Colour-groups and the causes are no longer operative. I have in the "Fauna Haw.", under "Aves," given a good deal of detailed information about

birds, insects and plants, and have shown how in the birds themselves the causes which developed the weird forms of the peculiar family Drepanididae no longer exist. Nothing but the severest competition for food could ever have produced such birds as *Pseudonestor, Heterorrhynchus* and *Chloridops,* the main food of which consists of a single article of diet, to obtain which as a regular diet a very special and grotesque structure has been acquired in each case. Such forms are the tips of twigs in a tree of descent —and they can give rise to nothing further. It might almost be said they are the tips of twigs which, having produced a terminal blossom, themselves die back. A comparatively easy and successful living is possible for a time, but with a slight change of conditions there only remains extinction. They have no chance to adapt themselves to new conditions. It is, I think, noteworthy how often one finds the 'finest' things to be very rare in islands, and I think this is clearly due to the fact that what a systematic student calls 'fine,' is usually a form peculiarly specialised in some particular way, and this means a very particular mode of life. Such 'fine' things are rare, because the conditions suited to their mode of life are few. They are unfortunately the first things to become extinct in Oceanic Islands.

Nov. 8, 1911.

I ought to say I have not finished with the 'colour' question yet, because I have a still more 'general' part than that which I am sending, dealing with 'species formation,' 'variation,' etc., in a general and more comprehensive way, considering the whole fauna together, birds, land-shells, insects and plants.

One who has a wide systematic knowledge of the whole fauna can picture a very different condition of affairs from the present—when the vegetation of the islands formed no true forest, but the islands were covered by a shrubby growth of woody Composites, Lobeliaceae, etc., with few or no trees; when the birds were of less specialised forms like *Himatione* and *Chlorodrepanis* of to-day, with no wonderful developments like *Pseudonestor* and *Heterorrhynchus,* and there were only a few types present, which were numerous in individuals and wandered from shore (where now they are absent) to the mountain tops, and there was a competition for food between individuals, not

to be seen nowadays. There were only a few species of Lepidoptera, mostly Pyralids and Micros., and the wasps, which necessarily came later than these, had no such field for securing food as at present. If the Müllerian theory is correct for these Hawaiian Hymenoptera, then the separation of the Colour-groups began and was developed gradually in past ages and the efficient causes are not observable now.

I stick out absolutely for the formation of all the genera of Drepanid birds within the islands—and what a time it must have taken to produce the extraordinary variety of forms, now seen in this exclusively Hawaiian family! Looking at the birds, one ceases to wonder at the hundreds of species of peculiar Achatinellidae in shells; at the fifty odd species of bees (*Nesoprosopis*) with their wonderful variety; at the 100 or more *Odynerus*, so varied in structure; at the vast genera in various groups of beetles; the (doubtless) hundreds of existing and very varied species of the fly genus *Drosophila*, etc. I doubt whether any but a systematist could rightly appreciate this wonderful fauna, or even a systematist who confined himself to a special group.

It has been a great advantage to me that I was able to work out all the Hymenoptera, Orthoptera and Neuroptera, a large part of the Coleoptera, practically all the Hemiptera (after Kirkaldy) as well as having largely studied many groups of the Lepidoptera and Diptera. Then I made a very large and perfect collection of the birds and wrote upon these also, made special studies in the land-shells, and have a moderate knowledge of the Botany.

Guppy, who wrote on the latter, could never have had his ideas, if he had studied the insects; and the conclusions of specialists like Lord Walsingham, who monographed the Micros., are in my opinion quite untenable (see p. 681).

Nov. 13, 1911.

If the Müllerian theory is true of the Hawaiian wasps, what probably happened is this:—

1. There was a very ancient immigrant *Odynerus* (? whence) which gave rise to the vast majority of the forms now present.
2. It was a black-bodied insect with 2 (or more) narrowish pale abdominal bands.
3. The descendant species of this *Odynerus* may have

formed some Colour-groups (e. g. those with red markings) amongst themselves.

4. A later immigrant species from Asia arrived, a black species with dark blue iridescent wings (like and allied to *nigripennis* of to-day).
5. It became the most abundant and widespread of all species occupying all localities (as *nigripennis* does to-day, excepting in Kauai) on all the islands, except Kauai.
6. On Kauai *only*, *nigripennis* did not remain specifically the same, but gave rise to an equally common, allied species *O. radula*, with two yellow bands.
7. This became *and is* the dominant species on Kauai, and (*a*) may have formed the model for the chief (and almost only) Colour-group on that island, or (*b*) it is likely that the pale-banded group may have previously been a feature of Kauai, and absorbed the immigrant *nigripennis*-like insect (which became also structurally modified), or (*c*) the large series of Kauai forms may have at least developed their dark blue iridescent wings after the pattern of the *nigripennis*-like insect, and it acquired their bands.
8. In the open country of all the islands (excepting Kauai) whether above or below the forest, a large number of species remain, which probably most nearly show the superficial appearance of the original immigrant *Odynerus.*
9. This open country is that which would always (from the nature of the avifauna) have been either devoid of insectivorous birds or very sparsely frequented by them.
10. On Hawaii, the big island, the tendency is decidedly to one uniform condition of blackness and the formation of a single group—the pale-banded forms tending to lose the bands, or having quite lost them in the female sex; the red-marked species having the red marks diminished, faint or dull, as compared with the nearest allied species on the neighbouring islands. Hawaii is very rich in birds.
11. Except on Kauai, the ancestral character of the yellow bands is confirmed by their retention by those species which are least peculiar as compared with foreign forms, and by the fact that almost

any species is, as a very rare variety, liable to produce such a form, the band in such case being often very faint and fine, only found on one segment, sometimes fragmentary, or represented only on the ventral surface, where it is, of course, invisible in life.

12. Though the *nigripennis* group is probably of much later origin in the islands than the other, which it is to be noted has produced within the islands *distinct genera* (*Nesodynerus, Pseudopterocheilus, Chelodynerus*), yet it also is ancient; for it is represented by a highly modified species *O. localis* in Kauai, and by a second distinct one on Oahu, *O. epipseustes.* In *localis* such important structures are modified that much time would be required.
13. Consequently the arrival of the ancestor of the *nigripennis* group may well have happened at a time when the condition of the avifauna was very different.
14. The *nigripennis* group of *Odynerus* might possibly have become much more numerous in species had not the islands been already occupied by a great number of forms developed from the earlier immigration. We may compare the case of the bird family Drepanididae, with that of the later-arriving Meliphagidae.

Importance of the Hawaiian fauna in the study of Evolution.

Nov. 4, 1911.

I believe the Hawaiian islands are for the solving of many most important problems, without any equal elsewhere as at present known. The excessive complications of great continental faunas or continental islands are absent, yet the fauna is itself large enough to present many of the same phenomena. I saw this many years ago and referred to it in my paper on the "Vertebrata" (under the Birds) in the "Fauna Hawaiiensis."

Nov. 13, 1911.

I cannot follow the de Vries people at all. Their mutations and fluctuations are distinctions without any particular difference to me. They know nothing about the instability of the latter. For instance, suppose we

get by selection a melanic form from a pale creature. If it is then placed under exactly similar conditions to those of the parent pale form, it is certainly likely to revert, but if it is, as probably would be the case in nature, maintained for generations, it seems to me the whole life of the creature would be profoundly modified, and germ-cells and many other parts would be affected. Many important external agencies would be changed, absorption of heat, e. g. They seem to expect to see everything revert, because it is known to do so in a limited number of examples and after a few generations.

One of the most important parts of my introduction will deal with insects known to have been introduced. Some of these produce a brood every three weeks or so throughout the year. Is it not remarkable that after years in the islands, and having come from very different countries, we do not find these producing varieties under such new conditions, and after so many generations?

It seems that it ordinarily takes a great time to start a variable condition, but it does come in the end, for, if we look at the species which are peculiar to the islands, but are comparatively recent arrivals (i. e. not very peculiar and which have not yet given rise to allied species), we see that these are almost always *excessively variable.* Consider how constant are the undersides of *Vanessa atalanta, cardui*, etc., yet our *V. tammeamea*, Esch., allied to these, presents the most remarkable variations constantly. *Hypenodes altivolans,* hardly different from a species found in England, New Zealand, etc., is extraordinarily variable with us, and the same is true of many other Hawaiian species.

Nov. 15, 1911.

I am much impressed with the stability of species for many generations under changed conditions—to which I have referred previously.

Of course a species already in a highly plastic condition would presumably be more likely to exhibit change in a short time. But—

(*a*) In Blackburn's collection (of which I have a large part), formed thirty years ago, variable species exhibited the same varieties then as now.

(*b*) Introduced species from other very diverse countries have not altered after many generations. This

applies to species which are *known* as being plastic outside the islands, i. e. ones which have formed marked varieties or races in countries different from the one whence they were imported to our islands, but which they, no doubt, reached naturally, and at a much more remote period.

From my knowledge of insects generally I should say that species we call very variable are usually really constant in their varieties, i. e. the varieties themselves are of regular occurrence *in nature*—some rarer some commoner, like species. It evidently requires *much time* to alter either species or varieties. What a time it must have taken to produce the eighteen genera of Drepanididae, a family peculiar to the islands! This and the extreme specialisation of so many of the genera seem to point to an ancient excessive competition, unrealisable on present conditions.

I suspect that some day a widespread cause inducing plasticity will be discovered. It must be remembered that many of our commonest imported insects have no enemies at all to keep them constant by selection, but they have not begun to vary *yet.**

* [The following contribution to this discussion was contained in a letter written by Dr. Perkins from Honolulu, May 20, 1912 :—]

I am astonished after my experience here at the permanency of specific characters. When I see the enormous changes in climate and general conditions produced by the white man's destructive work, and compare examples of all sorts of insects collected to-day with those taken over 75 years ago by old collectors, or 30–40 years ago by Blackburn, I should have expected to have found at least some perceptible difference between the individuals after so many generations (things breed all the year here, many of them average a brood to a month or six weeks).

Again, the conspicuous dominant wasps of the genus *Polistes* introduced nearly half a century ago—more conspicuous and fierce, and more numerous than any *Odyneri*—might have been expected to influence the more plastic of the indigenous species, viz. those which have a coloration that could be easily changed to resemble the new arrivals. In general it appears that an enormous time must be allowed for specific change, unless it occurs abruptly and suddenly. We have lately had a tropical American *Odynerus* introduced here, of quite a different type from our groups; but its appearance could easily be arrived at by some of the native species. This new species (no doubt, imported by man) is already, after a year or so, a most dominant species. Theoretically it should be badly off, as it would be unknown to our endemic birds, etc., and it is not very startling in colour.

14

[*From the* PROCEEDINGS OF THE ZOOLOGICAL SOCIETY OF LONDON, 1912.]
[Published June 1912.]

Mimicry amongst the Blattidæ; with a Revision of the Genus *Prosoplecta* Sauss., and the Description of a new Genus. By ROBERT SHELFORD, M.A., F.Z.S.

(Plate XLVIII.* and Text-figures 42–46.)

Speaking in general terms the Blattidæ may be regarded as a somewhat defenceless group of insects, preyed upon by numerous enemies both vertebrate and invertebrate, to escape which they must rely on their skulking, cryptic habits, and on a high degree of speed when disturbed. In accordance with their cryptic mode of life most cockroaches are obscurely coloured, harmonising more or less perfectly with their inanimate surroundings, or, at any rate, displaying no conspicuous markings to attract the attention of potential foes.

Exceptions to this cryptically coloured type of cockroach, however, exist in some numbers and are dealt with in the following pages.

The Australian continent is the headquarters of a group of Blattidæ which presents all the features customarily associated with extreme unpalatability. This group is the *Polyzosteria* section of the sub-family Blattinæ. Nearly all the species are apterous and expose themselves freely, and many are endowed with a most repulsive odour. Mr. W. W. Froggatt informs me that *Polyzosteria limbata* Burm., *P. cuprea* Sauss., and others of this

* For explanation of the Plate see p. 376.

genus and of *Platyzosteria* Br., are fond of sunning themselves on the tops of posts and tree-stumps. Commander J. J. Walker when collecting in Australia frequently encountered a species, *Cosmozosteria lateralis* Walk., which emitted so vile a smell that he always refrained from touching it. This species is russet-brown in colour with some variable yellow markings on the thoracic and abdominal tergites, and on each posterior angle of the ninth abdominal tergite is a brilliant orange-red spot; when the insect is at rest these two spots are almost concealed, the ninth tergite being somewhat retracted within the preceding one, but on the approach of an enemy the apex of the abdomen is elevated and slightly distended so that the orange spots become conspicuously displayed to view. A better example of a warning signal associated with highly distasteful properties could not be found.

Prof. Baldwin Spencer, writing in 'Nature' of July 28, 1892, p. 309, says:—"One morning, when Mr. Frank Connelly and myself were digging for worms, we accidentally cut in two a cockroach. From between the segments in its back it poured forth a milky-white fluid, possessing an odour so execrable and pungent that it drove us from the spot." It is unfortunate that the species was not identified, but I expect that it was one of the *Polyzosteria* group.

Commander J. J. Walker says of *Periplaneta fortipes* Walk., a synonym of *Platyzosteria novæ-zealandiæ* Br., that it is "very evil-smelling," but that its smell "is quite mild in comparison with several of the Australian species." (Entom. Monthly Mag. (2) xv. p. 70 (1904).)

Dr. G. B. Longstaff recently took this species in some numbers in New Zealand, finding it, however, not in exposed situations, but under logs and the bark of dead trees. Quoting from his note-book Dr. Longstaff tells me that one specimen had a "moderate cockroach odour, evanescent," of another that it had "a strong peculiar fetor." The discrepancy may possibly be accounted for by sexual differences (see remarks later on *Eurycotis floridana* Walk.).

All the Australasian species of the *Polyzosteria* section appear to be conspicuous insects. Many of them are shining black, a colour which is noticeable enough in Nature when associated with free exposure; others are black edged with yellow, or with red legs. The species of *Anamesia* Tepp., are chestnut-brown banded or margined with yellow. *Cosmozosteria zonata* Walk., is black, banded with yellow or orange. Many of the species of *Polyzosteria* Burm. are bright with metallic colours, and *Euzosteria mitchelli* Angas, with its bronzy dorsal surface, spotted and barred with orange or yellow, its pale yellow ventral surface and sky-blue tibiæ, is the most gaudy cockroach yet discovered In the New World the *Polyzosteria* section of the Blattinæ is represented by the genera *Eurycotis* Stål, and *Pelmatosilpha* Dohrn. The species do not appear to be so blatantly conspicuous as their Australian relatives, but it seems likely that most, if not

[3]

all of them, are endowed with very distasteful properties. Rehn and Hebard (Proc. Acad. Nat. Sci. Philadelphia, 1905, p. 32) write of *Eurycotis floridana* Walk.:—" When seized these insects emit a vile-smelling oily fluid. The females always produced far more of this than the males." This is a chestnut-brown species, but the larvæ have the thoracic tergites margined with pale yellow; it is found hiding under logs and stones. It is evident, then, that amongst the Blattidæ a nauseous odour or taste is not invariably associated with aposematic habits,—the insects themselves may be conspicuous enough when unearthed from their hiding-places, but the point is, that they do not voluntarily expose themselves, as do so many of the Australian *Polyzosteriae*. Further confirmation of these rather puzzling facts is afforded by observations made by Mr. G. A. K. Marshall on two South-African cockroaches, *Deropeltis erythrocephala* Fab. and *Aptera fusca* Thunb. The first of these belongs to the subfamily Blattinæ and to a genus in which the males are winged and the females apterous. In both sexes the posterior margin of the fifth abdominal tergite is sinuate *, and beneath the tergite are situated glands from which a sticky fluid exudes when the insects are seized. Though it is reasonable to suppose that this fluid is a distasteful secretion of a defensive nature, it must again be noted that *D. erythrocephala* and probably most of the other species of the genus hide beneath stones and do not expose themselves voluntarily. Most of the species of *Deropeltis* are bulky insects, piceous in colour; in *D. erythrocephala* the head and legs are red. *D. dichroa* Gerst., from the Gold Coast, has a large fulvous macula on each side of the sixth and seventh abdominal tergites; whilst *D. paulinoi* Bol., from Angola, is equally conspicuously marked with rufous fasciæ on the lateral margins of the pronotum. The female of *Aptera fusca*, one of the Perisphæriinæ, is a large, robust insect, piceous with conspicuous transverse bands of ochreous or rufous; when seized it exudes a violet fluid which stains the fingers; this species also has cryptic habits. This is absolutely all the information that I have been able to gather about unpalatable species of Blattidæ, and it certainly is little enough. It is perhaps remarkable that the undoubtedly nauseous Australian species are not mimicked either by other orders of insects or by non-distasteful species of Blattidæ, but it must be remembered that the Orthoptera do not serve as models to other orders of insects—not a single instance has ever been recorded, and in Australia the paucity of cockroaches other than those of the distasteful group, is quite exceptional.

Although no Blattidæ are known to serve as models to mimicking insects, there are several which mimic insects other than Orthoptera, though in most instances the mimicry is of a very generalised nature. I have no reason to suppose that any of these mimetic Blattidæ are other than palatable.

* A generic character.

In a very superficial sort of way cockroaches and beetles may be said to be similarly constructed. In both the pronotum is large whilst the other thoracic tergites (in the winged species) are concealed; in both the membranous wings are covered by elytra or tegmina of a coriaceous or corneous texture. In fact only a slight modification of the cockroach-form is required to produce a distinctly Coleopterous appearance. The names *lycoides*, *buprestoides*, *coccinelloides*, *dytiscoides*, *silphoides*, given to species of Blattidæ by various authors, are sufficient evidence of their resemblance to beetles. It is quite an open question whether this generalised resemblance of certain Blattidæ to Coleoptera can be legitimately classified under the heading of Mimicry. It could well be argued that some of the species, at any rate, owe their beetle-like form to convergence in development, or, to use Sir Ray Lankester's term, that cockroaches and beetles are homoplastic forms. On the other hand, as will be seen later, some of the cases of resemblance are so detailed and close that it is impossible to regard them as anything but examples of true mimicry, and it becomes most difficult to draw the line between the two classes of resemblance. For convenience' sake, at any rate, throughout this paper the Blattidæ which resemble insects of other orders will be termed "mimics."

Examples of generalised mimics of the Coleoptera are furnished by species of *Pachnepteryx* Br., *Caloblatta* Sauss., *Paratropes* Serv., *Phoraspis* Serv., *Eustegasta* Gerst., *Achroblatta* Sauss., *Corydia* Serv., *Areolaria* Br., and *Hypnorna* Stål, whilst several species in other less specialised genera might be quoted. Of not one of these species can it be said that it is very like any definite species of beetle. *Eustegasta buprestoides* Walk., from West Africa, is a metallic green cockroach with round yellow spots on the tegmina, and as its name implies, it is very like a Buprestid beetle. But in spite of the most diligent search amongst collections of Buprestidæ, I have never found a species which by the greatest stretch of imagination could be regarded as even an indifferent model for the cockroach.

Belt speaks of mimetic cockroaches in 'The Naturalist in Nicaragua' as follows:—"The phosphorescent species of Lampyridæ, the fireflies, so numerous in Tropical America, are equally* distasteful, and are also much mimicked by other insects. I found different species of cockroaches so much like them in shape and colour that they could not be distinguished without examination. These cockroaches, instead of hiding in crevices and under logs like their brethren, rest during the day exposed on the surface of leaves, in the same manner as the fireflies they mimic"†. It was with much interest that I found in the Hope Museum, Oxford, a specimen of the cockroach *Achroblatta luteola* Blanch., with the following note in

* *I. e.* with the non-phosphorescent species, by which Belt appears to mean the beetles now known as Lycidæ.

† I quote from the Everyman's Library Edition (Dent & Sons, 1911), p. 243.

Westwood's handwriting attached to it:—"This Blatta lives on trees and closely resembles in its habits some of the large Lampyridæ [T. Belt]." This is doubtless one of the species mentioned by Belt in his book, and I had great hopes of being able to match it with a definite species of Lampyrid beetle, but the most diligent search through the Godman-Salvin collections of Central American insects failed to reveal a "model" to the cockroach. The Malacodermatous appearance is undoubtedly but generalised, not specific. The same may be said of *Hypnorna amœna* Sauss. & Z., also from Central America. This Blattid has all the appearance of a small Longicorn, but it actually resembles no particular species of that family. It may, of course, be argued that further collecting will bring to light species of beetles which can legitimately be regarded as models to the cockroaches, but I do not think that this is in the least degree probable. Our knowledge of the Central American Coleoptera must now be nearly complete, speaking from the point of view of the systematist, and the West African *Eustegasta buprestoides* is so very abundant that it might reasonably be expected that its supposed model would be, if not abundant, at any rate in sufficient numbers to permit of some specimens falling into the hands of collectors. At the very end of this paper I describe two new species of Blattidæ, belonging to a new genus, which also must fall into the category of generalised Coleopterous mimics.

The two species of the Oriental genus *Thyrsocera* Burm. are shining black cockroaches with large yellow spots on the tegmina, a type of coloration frequently met with amongst the Endomychidæ of the same region. These cockroaches, though far larger than, and in other points quite unlike any Endomychidæ known to science, may possibly be regarded as part of a "convergent group," the dominant or "central" members of which are the yellow-spotted Endomychidæ (genus *Eumorphus*). A generalised resemblance to certain families of Rhynchota is also shown by some Blattidæ. For example, some species of *Holocompsa* Burm. and *Hypercompsa fieberi* Br. are rather like small Capsidæ; the illusory effect is produced by the tegmina, which are largely membranous and hyaline, though opaque and coriaceous at the base; the resemblance does not bear a very close examination. *Homopteroidea nigra* Shelf. is not unlike some small Fulgorid or Jassid. Mr. J. C. Kershaw found at Hong-Kong, under a stone, several little black Pentatomids, and in company with these a similarly coloured and shaped cockroach which appears to be identical with *Pseudophyllodromia parilis* Walk., and he suggested * that the cockroach mimics the bug. Having seen the specimens I prefer to regard them as examples of syncryptism or of homoplasy.

Linnæus, deceived by the Coleopterous appearance of *Corydia petiverana*, placed it in his genus *Cassida*. Mr. T. Bainbrigge

* In a letter to Professor Poulton.

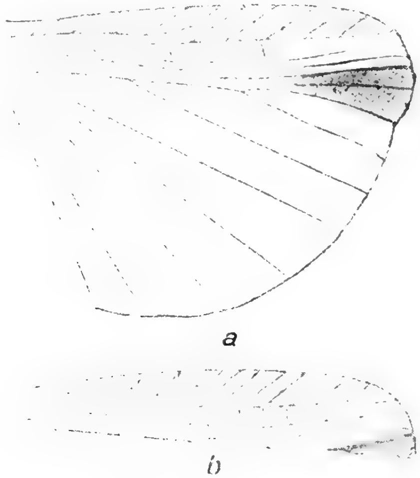
Fletcher, who has watched this insect in a state of nature in Ceylon, tells me that when it is flying it looks very like a conspicuous Agaristid moth, *Mimeusemia ceylonica* Hmpsn. The resemblance is certainly not very striking when the dried insects are seen side by side in a cabinet, but no field-naturalist will attach very much importance to that, and in any case Mr. Fletcher does not maintain that the resemblance is detailed and accurate, but merely generalised.

The power which the females of species of *Perisphaeria* and *Pseudoglomeris* have of rolling themselves up into spherical balls when alarmed is well known, and on account of their convex form and black shining colour, they undoubtedly bear an extremely close resemblance to the pill-millipedes which are so abundant in the tropics. But here again I doubt if any particular species of millipedes are copied. It is certainly a fact that whilst two species of *Perisphaeria* were not infrequently met with in Sarawak, both rather small, black species, I never once found a millipede corresponding in size or colour to them. It is by no means certain that the pill-millipedes are distasteful animals—on the contrary, it is quite probable that they are palatable but well protected by their hard integuments and power of rolling up into a ball. The same habit is shown by many terrestrial Isopoda, but no one considers that the Isopods mimic the Millipedes or the Millipedes the Isopods. The similarity of habit and form is attributed to homoplasy, and I see no reason why the same habit of the cockroaches should not also have been quite independently evolved.

Having now passed in rapid review the principal genera of Blattidæ which show a more or less generalised resemblance to insects of other orders, it only remains to consider in greater detail the genus *Prosoplecta* Sauss., nearly all the members of which present a remarkably close and detailed resemblance to definite specific models amongst the Coleoptera, so far as these have been discovered. With but two exceptions the species of *Prosoplecta* present an appearance which is conveniently summarised as Coccinelliform; that is to say, the outline of the body is oval verging on spherical, the form is markedly convex, the integuments are smooth and nitid, the tegmina are corneous with obsolescent venation and do not extend beyond the apex of the abdomen, the legs and antennæ are short and, finally, the insects are gaily coloured. It is scarcely necessary to point out that the Coccinelliform type is found amongst other families of Coleoptera besides the Coccinellidæ: it is found, for example, amongst the Cassididæ, Chrysomelidæ, and Galerucidæ, whilst many of the Scutelleridæ, a family of Hemiptera, also present much the same facies. The two species, *P. coccinella* Sauss. and *P. bipunctata* Br., are, in spite of the name of the first, far less Coccinelliform than the other species of the genus, and may certainly be regarded as more primitive. The form is more depressed, and I am inclined to suppose that these two species,

though distinctly Coleopterous in appearance, fall into the category of generalised beetle-mimics.

Text-fig. 42.



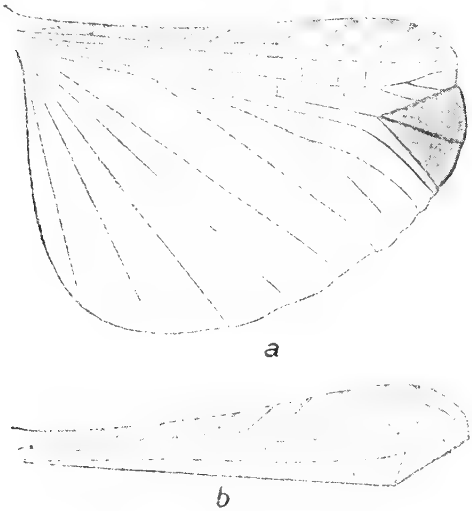
Hemithyrsocera sp.

Wing expanded (*a*) and folded (*b*). The apical triangle is shaded.

In the genus *Prosoplecta* the wings have been modified in a very remarkable manner, and as their structure has never been properly described and is of particular interest when considered together with the mimetic resemblances of the genus, it is necessary to go now into some details of the cockroach wing-structure. The wing of a cockroach such as *Blattella germanica* L., is divided longitudinally into an anterior and a posterior part; the anterior part is more or less rigid, being strengthened by numerous longitudinal and transverse veins, while the larger posterior part is supplied only with radiating longitudinal veins. When the wing is closed the posterior part shuts up like a fan and folds underneath the anterior part, which remains stiff and unfolded. At the apex of the line of division between the anterior and posterior parts of the wing is a quite inconspicuous area which, when the wing is closed, appears as a minute fold lying on the top of the anterior part. This insignificant area, which belongs neither to the anterior nor to the posterior part of the wing, is the forerunner of a part of the wing, which in some genera of Blattidæ assumes relatively enormous proportions. In the genus *Hemithyrsocera* (text-fig. 42) this area has increased in size and is conspicuous enough to have attracted the attention of systematists, ever on the look out for characters diagnostic of the difficult genera of the subfamily Pseudomopinæ. The area is now known as the triangular apical area, or more

simply, the apical triangle. In the genera *Ectobius*, *Theganopteryx*, and *Chorisoneura*, to select but three examples from many, the apical triangle is still larger, has clearly defined boundaries, and in the closed wing appears either rolled up in a

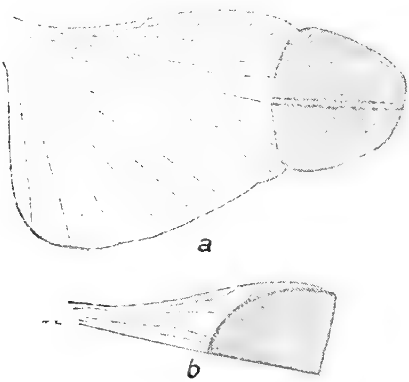
Text-fig. 43.



Chorisoneura taeniata Sauss. & Z.

Wing expanded (*a*) and folded (*b*). The apical triangle is shaded.

Text-fig. 44.



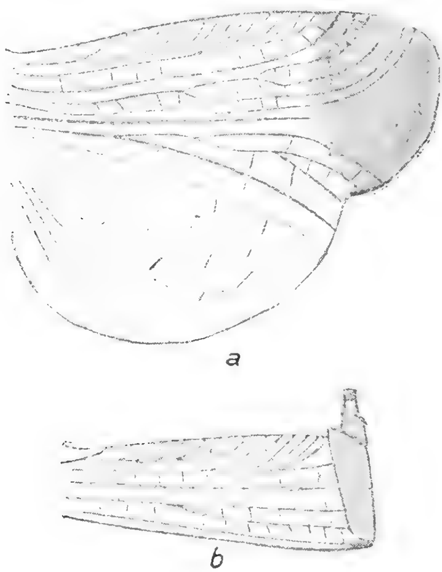
Anaplecta decipiens Sauss. & Z.

Wing expanded (*a*) and folded (*b*). The apical area is shaded.

spiral (*Ectobius* and *Theganopteryx*) or as a doubled fold (*Chorisoneura*), lying on the top of the anterior part of the wing (text-fig. 43). Between this stage of wing-development and that

of the genera *Anaplecta* and *Plectoptera* there is every grade of transition. In a typical species of *Anaplecta* the apical triangle has become a large parabolic area, now known as the apical area, almost equal in size to the rest of the wing, over which it is doubled back when the wing is folded (text-fig. 44). In the species *Anaplecta variipennis* Shelf., the passage from an apical triangle to an apical area can be traced; for some individuals exhibit the *Chorisoneura* type of wing-structure; in others is seen the extension of the apical triangle by the widening out of the angle made by the intercalation of this area between the anterior and posterior parts of the wing; finally, some specimens exhibit the complete development of the apical area, with its straight base-line, cutting the wing transversely into two halves, so that the longitudinal veins of the anterior part of the wing and the first axillary veins of the posterior part, no longer impinge on the outer margin of the wing, but on the base-line of the apical area. The summit of wing-development is attained by *Diploptera dytiscoides* Serv., for in this species the apical area is closely veined, though the veins are not in organic continuity with those of the other part of the wing.

Text-fig. 45.



Prosoplecta nigrovariegata.

Wing expanded (*a*) and folded (*b*). The pseudapical area is shaded.

A cursory glance at the closed wing of any species of *Prosoplecta* (text-fig. 45) leads the observer to suppose that it is constructed on the same principle as that of *Ectobius* and *Thegan-*

opteryx, for there is visible a large curled-up spiral lying on the dorsal face of the anterior part of the wing. But when the wing is spread out it is seen that the method of wing-folding is quite peculiar. The triangular apical area though large is not sharply defined as in *Chorisoneura*, *Theganopteryx*, etc., and the spiral fold involves not only this area but also the apical portion of the anterior part of the wing, and a minute portion of the apex of the posterior part. The part of the wing involved in the spiral fold constitutes in fact a *pseud-apical area*, and it is suffused with a dark fuscous colour, just as the true apical area of *Anaplecta* and the apical triangle of *Chorisoneura* etc. are coloured more deeply than the other parts of the wing.

There can be little doubt that this type of wing-folding, unique amongst the Blattidæ, is a modification brought about by the mimetic resemblance, and it is certainly a very singular one. The student of the mimetic resemblances which exist between insects not genetically related, frequently comes across remarkable modifications of structure, modifications which are alien, so to speak, to the constitution of the insects; here a concentration of pilosity to form a false spine, there a patch of colour, a shortening of elytra, or a thickening of legs or antennæ. But invariably he will find these are modifications of structure absolutely essential to the success and perfection of the mimicry; if he looks deeper he will find that mimicry has not touched parts which are concealed, and which therefore play no part in the mimetic resemblance. In short, mimicry is essentially a superficial likeness between organisms fundamentally different. Yet here in the species of *Prosoplecta* we have an exception to this very general rule. The wing of the cockroach does not mimic the wing of the beetle, but it has been modified because of the mimicry between the two orders of insects, or in other words, in this case mimicry *has* affected structures which play no part in a mimetic resemblance. To speak in the crudest of metaphors, it appears as if in the production of these Coccinelliform cockroaches Nature had been in a tremendous hurry. The immediate ancestors of *Prosoplecta* were probably narrow and moderately elongate cockroaches with wings of the *Hemithyrsocera* type; passage from this form to a short convex form might have proceeded along at least two lines—either the wings might have become gradually shorter *pari passu* with the tegmina, as in certain species of *Ceratinoptera*, *Allacta*, etc., or the wings could have been adapted to an ovate, abbreviated body-form by passing through a *Chorisoneura*-like stage to the *Anaplecta* type. As a matter of fact the evolution of *Prosoplecta* did not travel along either of these lines,—the necessary shortening of the wing when in repose has been produced by a rolling up of as much of the wing as was necessary for the purpose, quite independently of the boundaries between the intercalated apical triangle and the rest of the wing, and so in defiance of the rule observed in all other species of the family.

[11]

The geographical distribution of *Prosoplecta* is as follows:—Eight of the species are found in the Philippine Islands, one in Celebes, the remaining three in Batchian and Ceram. None has yet been discovered in the Great Sunda Islands, so that the distribution is discontinuous and serves to emphasize the view that if the Philippines are to be regarded as a part of the Indo-Malayan region, their separation from adjacent land is of very great antiquity. The Philippine Islands constitute an area in which insect mimicry has attained great perfection. That is shown not only by these wonderful cockroaches mimicking Coleoptera, but Professor Poulton tells me that some of the most wonderful examples of mimicry amongst butterflies are known from these islands only, *e. g.* the distasteful Danaine genus *Hestia* is mimicked very closely by a Satyrine and an Elymniine. Again, the gorgeous little Curculionidæ of the genus *Pachyrhynchus* are mimicked by other weevils, by Longicorns, by Cetoniids, and by a cricket*. A comparative study of mimetic insects in geographically adjacent but zoologically distinct areas, such as Borneo, the Philippines, and Celebes, is a piece of research that would surely yield some very interesting results.

I now give a synoptical key to the genus *Prosoplecta* with descriptions of all the species known to me. It will be observed that I have not always been able to pair a species of *Prosoplecta* with a definite Coleopterous model, but I am pretty confident that these models will eventually be found. I have not had access to comprehensive collections of Philippine Coleoptera, and so it is chiefly the Philippine *Prosoplectae* which for the present I am not able to match. It is unfortunate that Semper's collection of Philippine Coleoptera is broken up and dispersed; Stål purchased his Orthoptera for the Stockholm Museum, and here it was that I found four new species of *Prosoplecta*, but the Coleoptera captured at or about the same time and in the same districts, I have not been able to trace.

Key to the Species of Prosoplecta.

1. Less convex species. Tegmina with a smooth flattened tubercle near the middle of the anal vein.
    2. Pronotum piceous, margined all round with hyaline testaceous .... *P. coccinella* Sauss.
    2′. Pronotum bright rufous .... *P. bipunctata* Br.

1′. Very convex species. Tegmina without flattened tubercles.
    2. Ground colour of tegmina ochreous or rufous.
        3. Tegmina maculate.
            4. Maculæ of tegmina piceous.
                5. Tegmina deeply punctate. (Pronotum with 4 maculæ.) .... *P. trifaria* Walk.

* Semper in his 'Animal Life,' p. 390 (International Scientific Series, 1890) gives figures of some of these mimetic insects, amongst them one with the legend "Phoraspis (grasshopper) mimics a Coccinella." This is an error, for the Phoraspis is a cockroach, apparently identical with *Prosoplecta ligata* Br. The species described below as *P. semperi* is a much better mimic of the Coccinellid figured by Semper than is *P. ligata*. Semper's figures (and error) are reproduced by Dr. Wallace in his 'Darwinism.'

5′. Tegmina not deeply punctate.	
6. Ground colour of tegmina ochreous......	*P. nigroplagiata*, sp. n.
6′. Ground colour of tegmina rufous.........	*P. semperi*, sp. n.
4′. Maculæ of tegmina ochreous....................	*P. rufa* Kirby.
3′. Tegmina immaculate, margined with piceous .	*P. ligata* Br.
2′. Ground-colour of tegmina piceous or dark castaneous.	
3. Tegmina with not more than 4 rufous or ochreous maculæ.	
4. Tegmina distinctly punctate....................	*P. quadriplagiata* Walk.
4′. Tegmina indistinctly punctate	*P. nigra*, sp. n.
3′. Tegmina with more than 4 rufous or ochreous maculæ.	
4. Pronotum ochreous with 5 piceous maculæ .	*P. gutticollis* Walk.
4′. Pronotum piceous with the lateral margins hyaline ochreous.	
5. Maculæ on tegmina ochreous, more or less circular	*P. mimas*, sp. n.
5′. Maculæ on tegmina rufous, more or less band-like	*P. calophoroides*, sp. n.

PROSOPLECTA COCCINELLA Sauss. (Pl. XLVIII. fig. 5.)

Prosoplecta coccinella Saussure, Rev. Zool. (2) xvi. p. 324 (1864); Mém. Mexique, Blatt. p. 173 (1864).

♀. Head castaneous, vertex paler. Antennæ castaneous at base, remainder fuscous. Pronotum transversely elliptical, with the disc piceous, punctate, all the margins testaceo-hyaline. Tegmina dark castaneous, seriate-punctate; mediastinal area testaceo-hyaline; a minute, smooth, flattened tubercle at the humeral angle, a smaller one near the base of the radial vein and a larger one in the centre of the disc near the middle of the obsolete anal vein, testaceous. Wings infuscated, veins castaneous. Abdomen above fuscous, supra-anal lamina margined with testaceous, sub-bilobate; abdomen beneath piceous, nitid, sub-genital lamina very large, semiorbicular. Cerci short. Legs castaneous.

Total length 8–9 mm.; length of tegmina 6·2 mm.; pronotum 2·5 mm. × 3·5 mm.

PHILIPPINE IS. (Paris Mus., *type*; British Mus.; Oxford Mus.).

The species is not coccinelliform, but is more like a little Chrysomelid.

PROSOPLECTA BIPUNCTATA Br. (Pl. XLVIII. fig. 2.)

Areolaria bipunctata Brunner von Wattenwyl, Nouv. Syst. Blatt. p. 261 (1865).

♀. Very similar to the preceding species, but the head is bright rufous, the palpi and the bases of the antennæ are piceous, remainder of antennæ clear testaceous. Pronotum rufous, lateral margins testaceo-hyaline, posterior margin opaque testaceous, with a fuscous line at the posterior angle. Tegmina piceous with mediastinal area testaceous, a flattened smooth tubercle, testaceous in colour, in the same position as the largest one in *P. coccinella*. Abdomen piceous above and beneath, faintly margined with testaceous. Coxæ and femora rufous, tibiæ and tarsi castaneous.

Total length 8·5 mm.; length of tegmina 6·5 mm.; pronotum 2 mm. × 3·5 mm.

Philippine Is. (Stettin Mus., *type*; Stockholm Mus., *coll. Semper*).

This species is also like a Chrysomelid.

Prosoplecta trifaria Walk. (Pl. XLVIII. figs. 4 & 11.)

Prosoplecta trifaria Walker, Cat. Blatt. Brit. Mus. p. 190 (1868) [= ♂].

Prosoplecta megaspila Walker, l. c. (1868) [= ♀].

Very convex, bright ochreous with piceous maculæ on pronotum and tegmina.

♂. Head and antennæ ochreous, a blotch on the frons, the labrum and apices of maxillary palpi, fuscous. Pronotum nitid, impunctate, transversely elliptical, with four small piceous maculæ on the disc. Tegmina seriate-punctate, a line between the bases of the radial and mediastinal veins, a short line above the humeral angle (which is pronounced), the inner margin of the left tegmen at the base, the portion of the right tegmen overlapped by the left and a round macula in the anal field, piceous. Wings infuscated. Abdomen above and beneath and the legs ochreous. Sub-genital lamina symmetrical with a median plication, posteriorly emarginate, styles minute. Cerci moderate.

♀. Similar, but the piceous markings on the tegmina heavier, and a large additional macula on the discoidal field beyond the middle. The abdomen beneath is castaneous, and the sub-genital lamina is very large and semiorbicular.

Total length (♂) 9 mm., (♀) 9·5 mm.; length of tegmina (♂) 7·5 mm., (♀) 8·1 mm.; pronotum 3 mm. × 4 mm.

Batchian (Oxford Mus., *types*, *coll. Wallace*).

The male is an admirable mimic of *Oides biplagiata*, and the female resembles a dark variety of the same insect (Chrysomelidæ, subfam. Galerucinæ). (Pl. XLVIII. figs. 3 & 10.)

Prosoplecta nigroplagiata, sp. n. (Pl. XLVIII. fig. 9.)

♀. Allied to *P. trifaria*, but distinguished by the obsolescent puncturation of the tegmina. Head rufous, vertex ochreous. Antennæ very slender, ochreous, with the apex infuscated. Pronotum ochreous, smooth, nitid, transversely elliptic, lateral margins hyaline, eight piceous maculæ arranged in a circle on the disc, the anterior pair almost fused, one pair minute. Tegmina ochreous, extreme base of mediastinal area hyaline, a macula at the base of the mediastinal area, a macula at the apex of the same area, a line joining these, a round macula on the middle of the anal vein, a curved line running from this over the humeral angle to the base of the tegmen, where there is another spot, the basal margin, a short line along the base of the sutural margin of the right tegmen, a large macula in the discoidal field beyond the middle, all piceous. Wings infuscated. Abdomen beneath rufo-castaneous, sub-genital lamina very large, semiorbicular. Cerci and legs rufous.

Total length 9·5 mm.; length of tegmina 7·9 mm.; pronotum 3 mm. × 5 mm.

PHILIPPINE Is. (Stockholm Mus., *type, coll. Semper*).

This species is a good mimic of *Prioptera sinuata* Oliv. (Cassididæ), and it is highly probable that a Coccinellid and perhaps a Chrysomelid also enter into mimetic relationship with these forms. (Pl. XLVIII. fig. 8.)

PROSOPLECTA SEMPERI, sp. n. (Pl. XLVIII. fig. 13.)

♀. Differs from *P. nigroplagiata* in the following details:—Size larger and broader; the general ground colour is rufous; there are only six maculæ on the disc of the pronotum, the anterior pair being suppressed; on the tegmina there are no lines joining any of the maculæ, the maculæ are as in *nigroplagiata*; there is an ellipsoidal piceous marking on the part of the right tegmen overlapped by the left; the disc of the subgenital lamina is suffused with castaneous.

Total length 10·5 mm.; length of tegmina 7·8 mm.; pronotum 3 mm. × 5·8 mm.

PHILIPPINE Is. (Stockholm Mus., *type, coll. Semper*).

Mimics *Leis dunlopi* Crotch (Coccinellidæ). (Pl. XLVIII. fig. 12.)

PROSOPLECTA LIGATA Br.

Cassidodes ligata Brunner von Wattenwyl, Nouv. Syst. Blatt. p. 262, pl. vi. fig. 28 (1865).

The species is known to me only from the description, which it is unnecessary to reproduce, since it occurs in the vade-mecum of all students of the Blattidæ.

PHILIPPINE Is. (Stettin Mus., *type*).

PROSOPLECTA RUFA Kirby*. (Pl. XLVIII. fig. 16.)

Prosoplecta rufa Kirby, Ann. Mag. Nat. Hist. (7) xii. p. 379 (1903).

This species is known to me only from the description, which I transcribe:—

"Long. corp. cum tegm. 9 millim.; lat. 5 millim.

"*Female.*—Light red, the tegmina somewhat darker. Pronotum smooth and shining, with the front border narrower than the hind border, transversely oval, with broad borders of subhyaline yellow covering the rounded off lateral angles, and the hind border yellow. Tegmina with the costal margin subhyaline yellow, a small yellow spot near the base, and another at one third of the length, both near the costa; between the second and the inner margin is a much larger, transverse, oval, yellow spot. Base of tegmina blackish. Wings, and a great portion of the middle of the abdomen beneath, as far as the base of the terminal segment, black."

PHILIPPINE ISLANDS, Mindanao (British Mus., *type*).

* It is probable that *P. rufa* is identical with *P. bipunctata*, a discovery made long after this paper was in the press. The extreme difficulty under which the paper was written must be my excuse.

Prosoplecta quadriplagiata Walk. (Pl. XLVIII. fig. 14.)

Prosoplecta quadriplagiata Walker, Cat. Blatt. Brit. Mus. p. 189 (1868).

♂. Head castaneous, antennæ rufo-testaceous. Pronotum piceous, smooth, nitid. Tegmina seriate-punctate, piceous, an orange-rufous macula at the base, another in the centre of the discoidal field. Wings fuscous. Abdomen above and beneath rufous; supra-anal lamina transverse, carinate, apex emarginate; sub-genital lamina as in *P. trifaria*. Cerci and legs rufous.

Total length 9·5 mm.; length of tegmina 8 mm.; pronotum 2·8 mm. × 4·5 mm.

Batchian (Oxford Mus., *type, coll. Wallace*).

Somewhat resembles an Erotylid of the genus *Aulacocheilus* or *Cyrtomorphus*.

Prosoplecta nigra, sp. n. (Pl. XLVIII. fig. 6.)

♂. Head rufo-testaceous, antennæ testaceous. Pronotum castaneous, impunctate, nitid, faintly striate transversely in the middle of the anterior half. Tegmina very faintly punctate, piceous, an orange rufous macula at the apex. Wings infuscated. Abdomen above and beneath rufous; supra-anal lamina transverse; sub-genital lamina as in the preceding species. Cerci and legs rufous.

Total length 9 mm.; length of tegmina 7·8 mm.; pronotum 2·9 mm. × 4·2 mm.

Philippine Is. (Stockholm Mus., *type, coll. Semper*).

The species is closely allied to *P. ligata* Br., and is probably a mimic of some Chrysomelid beetle.

Prosoplecta gutticollis Walk. (Pl. XLVIII. fig. 7.)

Prosoplecta gutticollis Walker, Cat. Blatt. Brit. Mus. p. 189 (1868).

♀. Head rufo-castaneous, paler on the vertex; antennæ testaceous, fuscous towards apex. Pronotum smooth, nitid, ochreous, lateral margins subhyaline, five piceous maculæ on the disc. Tegmina seriate-punctate, piceous, with the following large ochreous maculæ on each tegmen:—one in the mediastinal area, one in the middle of the marginal area, one at the base of the tegmen almost divided into two by a short piceous line on the humeral angle, and at its lower interior extremity just touching a macula in the middle of the discoidal field, a fifth macula near the apex of the tegmina. Abdomen above ochreous; supra-anal lamina triangular, cucullate, apex not emarginate. Abdomen beneath piceous, castaneous at base; sub-genital lamina semiorbicular, ample. Cerci and legs rufous.

Total length 9·5 mm.; length of tegmina 8·5 mm.; pronotum 3·1 mm. × 5 mm.

Ceram (Oxford Mus., *type, coll. Wallace*).

Very like a Coccinellid.

PROSOPLECTA MIMAS, sp. n. (Pl. XLVIII. fig. 15.)

♂. Head rufous, vertex paler; antennæ testaceous, infuscated towards apex. Pronotum smooth, nitid, piceous, lateral margins broadly hyaline, a large ochreous macula at the posterior angles, enclosing three minute piceous spots, a minute **V**-shaped ochreous mark in the middle near the posterior margin. Tegmina minutely seriate-punctate, piceous, with the following ochreous maculæ on each tegmen:—one in the mediastinal area, one in the anal area extending on to the humeral angle, one in the middle of the discoidal field, one outside this and touching the radial vein, one at the apex, that on the left tegmen being larger than that on the right. Wings infuscated. Abdomen beneath, cerci and legs rufous, subgenital lamina as in the other species of the genus.

♀. Similar to the male but the head and abdomen darker, the macula in the anal field of the tegmina almost divided into two, two maculæ at the apex of the left tegmen. Supra-anal and subgenital laminæ as in the preceding species.

Total length (♂) 8·9 mm., (♀) 10·9 mm.; length of tegmina (♂) 7 mm., (♀) 9 mm.; pronotum (♂) 2·9 mm. × 4·6 mm., (♀) 3 mm. × 5 mm.

PHILIPPINE Is. (Stockholm Mus., *types, coll. Semper*).

PROSOPLECTA CŒLOPHOROIDES, sp. n. (Pl. XLVIII. fig. 19.)

♂. Head castaneous, vertex ochreous; antennæ testaceous, fuscous towards the apex. Pronotum impunctate, nitid, piceous with the lateral margins broadly ochreous. Tegmina seriate-punctate, piceous, with the following rufous maculæ on each tegmen:—a small circular one in the mediastinal area, a transverse one extending along the base of the tegmen over the humeral angle to the base of the radial vein, another broadly transverse extending across the middle of the discoidal field from near the sutural margin to the radial vein, a fourth circular in shape, near the apex of the tegmen. Wings infuscated. Abdomen and legs rufous; supra-anal lamina of usual shape.

Total length 9·2 mm.; length of tegmina 8 mm.; pronotum 3 mm. × 4·9 mm.

NORTH CELEBES, Toli-Toli (Oxford Mus., *type, Fruhstorfer, e coll. Van de Poll*).

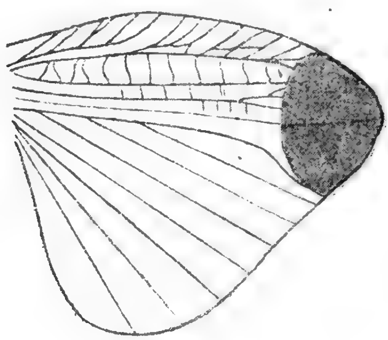
This is an admirably close mimic of the Coccinellid *Cœlophora formosa* Cr. (Pl. XLVIII. fig. 21), a specimen of which was taken by Fruhstorfer in the same locality and at the same time of year. The colouring and arrangement of the maculæ on the pronotum and wing-covers of the two insects correspond very closely, but in the beetles there is a transverse basal band on the elytra, whereas in the cockroach the corresponding patch of colour is made up of a band-like spot and an outer circular spot. The mimic is smaller than its model, and that appears to be rather the rule than the exception amongst this group of mimetic couples. *Anisolemnia distaura* Muls. (Pl. XLVIII. fig. 20) is another Coccinellid of nearly the same size and evidently also associated,

Description of a new Genus and two new Species of Blattidæ.

Genus Melyroidea, nov.

Head semiglobose, eyes small, far apart, situated on the sides of the head; antennæ with moniliform joints, slightly incrassated, not pilose, third joint twice as long as second. Pronotum quadrate, angles rounded, margins somewhat reflexed, not covering the vertex of the head; disc with slight elevations and depressions. Tegmina densely reticulated, obscuring the venation, semi-corneous in texture, anal field scarcely distinguishable; scutellum exposed. Wings with moderate apical field, which in repose is doubled on itself longitudinally and tightly rolled up, not folded back over the rest of the wing; traces of venation in the lower half of the apical field. Supra-anal lamina of female triangular or trigonal; sub-genital lamina divided by a sulcus; cerci variable. Legs slender, all the femora unarmed, tibiæ very sparsely spined, tarsi without arolia. Male unknown.

Text-fig. 46.



Melyroidea mimetica.

Expanded wing. The apical area is shaded.

This is quite one of the most remarkable genera of Blattidæ that has yet been discovered. The two species comprised in it present in their form and coloration a curious resemblance to Malacoderm Coleoptera, whilst in their structural features they appear to be intermediate between the Corydiinæ and Oxyhaloinæ [=Plectopterinæ]. The head with its globose front and vertex and widely separated eyes of small size, the cleft subgenital lamina of the female, and the naked tarsal claws are characteristic features of the Corydiinæ. On the other hand, the wing-structure is totally unlike that of the Corydiinæ, in which subfamily alone amongst the Blattidæ the anterior part of the wing is greatly developed, the posterior part folding beneath not in a fan-like manner. In *Melyroidea* the wing with its prominent apical area and posterior part furnished with radiating veins is

typically Plectopterine in structure, and this character, in conjunction with the fan-like folding of the posterior part of the wing, is overwhelming evidence in favour of the inclusion of the genus in the Oxyhaloinæ [=Plectopterinæ].

MELYROIDEA MIMETICA, sp. n. (Pl. XLVIII. fig. 17.)

♀. Head bright rufous, last joint of maxillary palpi fuscous, antennæ fuscous, except the basal and last apical joints, which are rufo-testaceous. Pronotum bright rufous, quadrate, anterior and lateral margins slightly reflexed, sides only slightly deflexed; disc with slightly rounded elevations, two anterior, two antero-lateral, and one, the largest, central. Tegmina dark castaneous, densely reticulated, mediastinal vein short, an oblique sulcus on the right tegmen marking the outer limit of the area overlapped by the left tegmen. Wings infuscated, radial vein bifurcated from the base, twelve costal veins, apices not incrassated, median vein simple, medio-discal area crossed by fourteen irregular venulæ, thrice as broad as the medio-ulnar area, which is crossed by eleven venulæ, ulnar vein bifurcate, transverse venulæ connecting it with the dividing vein, first axillary vein triramose; apical area about one third of total wing-length, its base obtusely angled, nearly equally divided longitudinally, some obscure venulations in the lower half. Abdomen piceous above and beneath, supra-anal lamina triangularly produced, sub-genital lamina cleft by a sulcus; cerci short, acuminate, rufous. Coxæ, femora, and bases of tibiæ testaceous, rest of tibiæ and the tarsi fuscous; formula of apical spines $\frac{1}{1}$, $\frac{0}{0}$, $\frac{0}{0}$, genicular spines on mid and hind femora; front tibiæ unarmed except for three apical spines, mid and hind tibiæ with one pair of basal and two apical spines above, with ten spines in a double row and two apical spines below.

Total length 13·5 mm.; length of body 11 mm.; length of tegmina 9·5 mm.; pronotum 4 mm. × 4 mm.; hind femora 4 mm.; hind tibiæ 4 mm.; hind tarsi 3 mm.

Hab. Uncertain, but probably near RIO DE JANEIRO.

One example (Miers collection, Oxford Museum).

The species is very like a Telephorid beetle.

MELYROIDEA MAGNIFICA, sp. n. (Pl. XLVIII. fig. 18.)

♀. Head bright rufous, maxillary palpi piceous, antennæ piceous, except for three joints beyond the middle, which are testaceous, slightly incrassated in the middle. Pronotum bright rufous, quadrate, very slightly broader anteriorly than posteriorly, all the borders somewhat reflexed, disc with two antero-lateral crescentic depressions. Tegmina green, the humeral angle and the part of the right tegmen overlapped by the left dark shining blue, densely reticulated but the veins elevated, mediastinal vein short, radial vein bifurcated from near the base, six highly irregular and branched costal veins, ulnar vein with three ramose branches, apex of anal vein attaining a point at

more than one third of the sutural margin. Wings very dark fuscous. Abdomen, cerci, and legs dark blue with metallic reflections, supra-anal lamina trigonal, sub-genital lamina cleft and valvular in appearance; cerci very long, with sparse erect pubescence, not acuminate. Formula of apical spines $\frac{1}{0}$, $\frac{0}{0}$, $\frac{0}{0}$, no genicular spine on front femora; front tibiæ with three apical spines and one spine beneath, mid and hind tibiæ with two widely separated spines above, four apical spines and a double row of spines beneath.

Total length 14 mm.; length of body 11 mm.; length of tegmina 11·5 mm.; pronotum 2·8 mm. × 3 mm.

ECUADOR.

One example (Saunders collection, Oxford Museum).

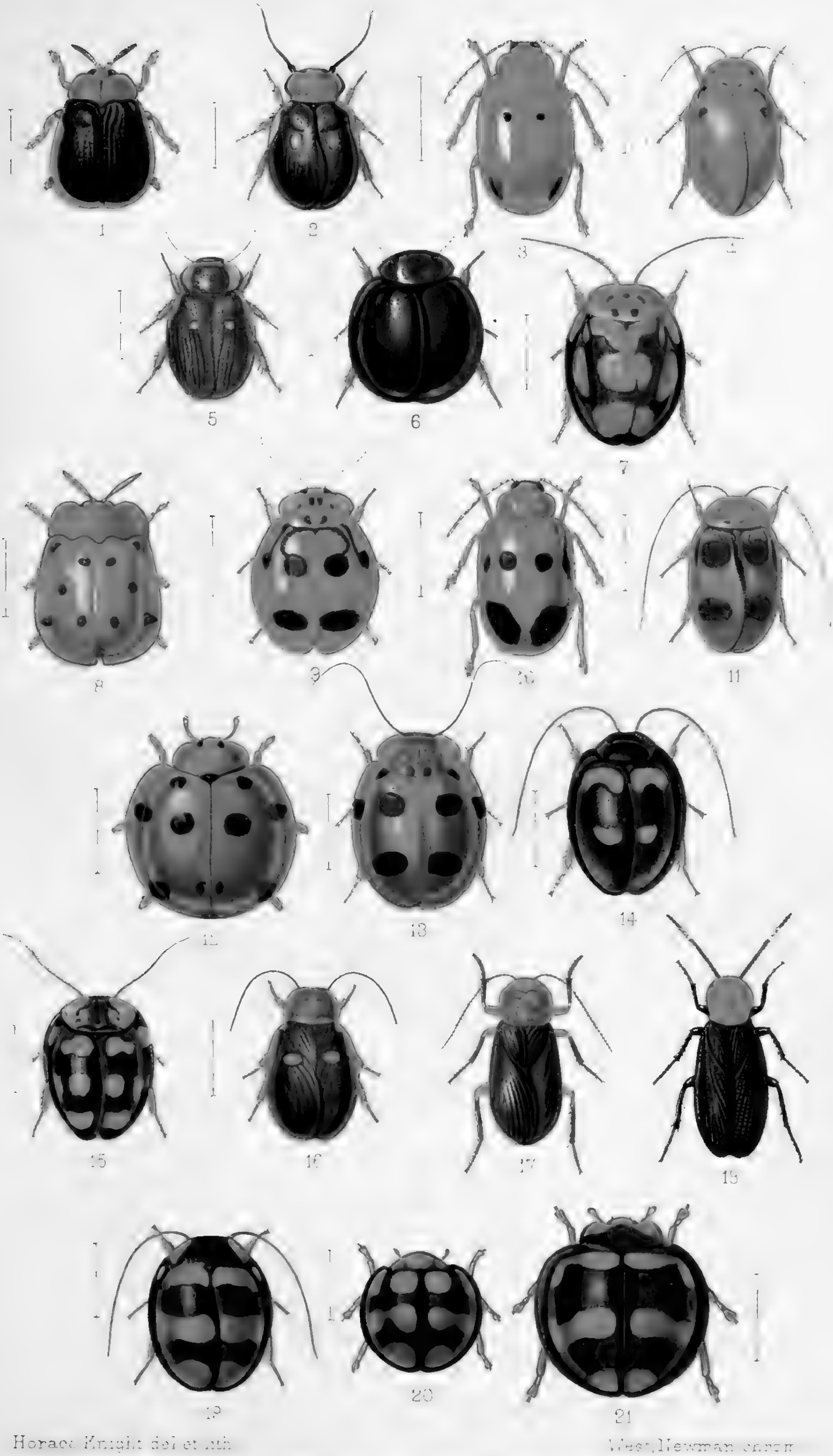
This gorgeous little cockroach is also very like a Telephorid, but I have not been able to match it with any particular species.

In the preparation of this paper I have been much indebted to the kind assistance of my friend, Mr. G. J. Arrow, who has diligently searched the rich collections of Coleoptera in the British Museum for models to some of the remarkable mimetic cockroaches described above. Mr. Arrow has also supervised the preparation of the plate accompanying this paper.

EXPLANATION OF PLATE XLVIII.

Fig. 1. *Megapyga eximia* Boh.
2. *Prosoplecta bipunctata* Br.
3. *Oides biplagiata* Jac.
4. *Prosoplecta trifaria* Walk., ♂.
5. *P. coccinella* Sauss.
6. *P. nigra*, sp. n.
7. *P. gutticollis* Walk.
8. *Prioptera sinuata* Oliv.
9. *Prosoplecta nigroplagiata*, sp. n.
10. *Oides biplagiata* Jac., var.
11. *Prosoplecta trifaria* Walk., ♀.

Fig. 12. *Leis dunlopi* Crotch.
13. *Prosoplecta semperi*, sp. n.
14. *P. quadriplagiata* Walk.
15. *P. mimas*, sp. n.
16. *P. rufa* Kirby.
17. *Melyroidea mimetica*, sp. n.
18. *M. magnifica*, sp. n.
19. *Prosoplecta cœlophoroides*, sp. n.
20. *Anisolemnia distaura* Muls.
21. *Cœlophora formosa* Crotch.



Horace Knight del et lith.

West, Newman chrom.

MIMETIC COCKROACHES AND BEETLE MODELS.

A NEW *CRAMBUS* FROM NEW ZEALAND.

BY E. MEYRICK, B.A., F.R.S.

Reprinted from "The Entomologist's Monthly Magazine," 2nd Series, Vol. xxii.

CRAMBUS OBSTRUCTUS, *n. sp.*

♂ ♀. 22–26 mm. Head and thorax light greyish-ochreous. Antennæ in ♂ minutely ciliated. Palpi 4, fuscous, white towards base beneath. Fore-wings elongate, narrow, somewhat dilated posteriorly, costa gently arched, apex obtuse, termen in ♂ slightly rounded, rather oblique, in ♀ straight and more oblique; pale brownish-ochreous, more or less strongly infuscated posteriorly; a rather broad irregular-edged white median streak from base to termen beneath apex, interrupted at ¾ by an irregular spot of the infuscated ground colour; sometimes some whitish suffusion along costa towards apex; cilia pale greyish-ochreous, sometimes partially infuscated, on extremity of streak mixed with white. Hind-wings pale whitish-ochreous-grey; cilia ochreous-whitish.

Three specimens taken near Lumsden, Otago, by Dr. G. B. Longstaff, who states that they flew into the train, on March 8th, 1910. This would imply that the species was locally abundant; it is an odd accidental discovery, but specimens might be easily overlooked amongst the common and variable *C. vittellus*, to which it is generally similar. I have collected at Lumsden myself, but not so late in the season. Type in Oxford University Museum; Dr. Longstaff very kindly gave me one of the other examples. This makes the 38th New Zealand *Crambus*, all endemic, besides an endemic genus developed from *Crambus* (*Orocrambus*) with six species; whilst in Australia there are only two species of *Crambus*, both immigrants.

Thornhanger, Marlborough, Wilts.:
February 21st, 1911.

IX. *Third Paper on the* Tetriginae (Orthoptera) *in the Oxford University Museum.* By J. L. Hancock, M.D., F.E.S.

[Read March 2nd, 1910.]

PLATE XLIX.

THE present studies are mainly founded on a series of forty-seven specimens of *Tetriginae* (Orthoptera) recently acquired by the Oxford University Museum. I am indebted to Professor E. B. Poulton and Mr. R. Shelford for the privilege of examining them. They have enabled me to add supplemental data to my two former papers published in the Transactions of the Entomological Society of London. These studies are made still more complete by the inclusion of notes founded on material in my private collection.

The section Cladonotae is represented by ten known genera in Africa; the following diagnostic table based on their distinctive characters may prove useful in separating them. Bolivar* recognised in his "Essai" (1887) species belonging to three genera, namely: *Xerophyllum, Trachytettix,* and *Pantelia.* Later Karsch† (1890) added species of *Acmophyllum, Trypophyllum, Hippodes, Hypsaeus,* and still later *Piezotettix,*‡ making eight genera recognised up to that time. I have recently added another genus, *Cladoramus,*§ and in the present paper supplemented a new one, *Medinophyllum,* bringing the whole number up to ten now known and differentiated in the table herewith presented. In each genus the type is given. The genus *Hypsaeus* and *Piezotettix* also occur in the Oriental region, while the other eight genera are confined to Africa.

* Ann. Soc. Entom. Belg. xxxi, 1887.
† Entomol. Nachricht. 1890.
‡ Berl. Entom. Zeit., xxvi, p. 196.
§ Trans. Entom. Soc. London, p. 217, 1907.

SYNOPTICAL TABLE OF AFRICAN GENERA OF THE SECTION *CLADONOTAE.*

1. Anterior and middle femora slender, elongate.

2. Pronotum compressed, foliaceous.

3. Dorsum of pronotum strongly compressed, highly foliaceous, angulate, pronotum in profile triangulate; first articles of posterior tarsi nearly twice the length of the third. Type *westwoodi*, Bol. — HYPSAEUS, Bol.*

3.3. Dorsum of pronotum subfoliaceous, more or less compressed, tectiform-cristate, in profile above straight or arcuate; first articles of posterior tarsi nearly three times the length of the third. Type *cultratus*, Stål . — PIEZOTETTIX, Bol.†

2.2. Pronotum not compresso-foliaceous, low obtuse tectiform, apex of posterior process abbreviated, widely rounded; elytra and wings wanting; first articles of posterior tarsi much longer than the third. Type *vicarius*, Karsch . — HIPPODES, Karsch.

1.1. Anterior and middle femora with both margins more or less foliaceo-dilate, carinae either entire, undulate, lobate, serrate or lobato-dentate.

4. Facial frontal scutellum more or less compressed, and either crenulate or spinulose, but not glabrous.

5. Crest of pronotum highly foliaceous above, more or less semicircular and regularly arcuate, the border smoothly longitudinally sulcate at the anterior two-thirds. Type *servillei*, Fairm. . . . . — XEROPHYLLUM, Fairm.

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* The African species are *aequalis*, Karsch, *inaequalis*, Karsch, and *angulatus*, sp. nov.

† The African species are *clypeatus*, Karsch, and *karschi*, Bolivar.

5.5. Crest of pronotum low, compresso-cristate, subfoliaceous, scabrous-spinose, produced forward, border above somewhat distinctly sulcate longitudinally and crenulate or erose spinulose posteriorly. Type *crenulatus*, Hanc. . . . . CLADORAMUS, Hanc.

6. Pronotum depressed.

7. Humeral angles outwardly produced, ampliate, laminate and serrate; eyes substylate; vertex very wide, and armed with distinct acute spine on each side. Type *bufo*, Costa . . . . . . TRACHYTETTIX, Stål.

7.7. Humeral angles wanting, dorsum of pronotum acute tectiform, anteriorly acute; vertex narrow; body apterous. Type *cristulata*, Bol. . . . . . PANTELIA, Bol.

6.6. Pronotum largely compressed and foliaceous, border above sharp, not at all longitudinally sulcate.

4.4. Facial frontal costa glabrous.

8. Margins of anterior and middle femora entire or below subundulate.

9. Foliaceous crest of pronotum perforate with foramina, border subsemicircular but little obtuse angulate above about the middle. Type *glabrifrons*, Karsch . . . . TRYPOPHYLLUM, Karsch.

9.9. Foliaceous crest of pronotum arcuate before the middle, not abruptly cristate, rounded angulate above at about the middle and deflexed backward, apex subobtuse or lengthily extended backward beyond the hind femoral apices, acuminate; inferior external carinae of posterior

femora entire. Type *xerophylloides*, Bol. . . . . MEDINOPHYLLUM, gen. [nov.*

8.8. Margins of anterior and middle femora below tri- or quadrilobate ; foliaceous crest abruptly highly elevated cristate forward, superior margin above undulate or sinuate ; inferior external carinae of posterior femora incrassate bearing lobes. Type *undulatum*, Karsch. . . ACMOPHYLLUM, Karsch.

Genus HYPSAEUS, Bol.

Ann. Soc. Entom. Belgique, xxxi, p. 200, 1887.

H. angulatus, sp. nov.

Face in profile subrounded, little sinuate below the frontal scutellum; scutellum elongate, margins entire, above curvate divergent, but subparallel below toward the median ocellus ; antennae inserted between the lower fourth of the eyes. Pronotum triangulate, strongly compresso-foliaceous, highly elevated and angulate above the middle, the summit of the angle rounded, anteriorly extended beyond the head, the inferior margin of process convex, the frontal apex obtuse-rounded ; margin above at the anterior half of crest arcuate toward the process in front, but flattened toward the elevated summit ; behind the middle deflexed backward and toward the hind apex very slightly undate-sinuate ; anterior and posterior halves of the upper margin subequal in length, the posterior process scarcely extended backward to the knees of the hind femora ; lateral lobes of pronotum posteriorly unisinuate, posterior angles obliquely excised behind. Elytra and wings wanting. Anterior femora elongate, little compressed, superior carinae entire, below slightly bilobate ; middle femora slender, margins entire ; posterior femora above ampliate, the superior carina strongly quadrilobate, the apical or fourth lobe triangular and acute; the superior external carina incrassate posteriorly ; ventral carina substraight at the apical three-fourths, and here bearing five indistinct small tubercles or lobuli ; first articles of the posterior tarsi much longer than the third, the first and second pulvilli nearly equal, the third much longer than the rest

* The genus *Medinophyllum* also includes the species *Acmophyllum conradti*, Bol.

in length. Colour fusco-rufescent, the crest of pronotum wholly opaque, margin above marked with fuscous.

Length of pronotum, ♂ 12.5 mm.; height at the middle, 9 mm.; posterior femora length, 7.6 mm.

Locality: Bitje Ja River, S. Cameroons (Rosenberg).

One example in the author's collection. This species resembles *H. aequalis*, Karsch, but is distinguished by the smaller stature and by the more distinct right angle summit above.

Genus Xerophyllum, Fairm.

Ann. Soc. Entom. France, p. 246, 1846.

The following table is a revision of the species of the African genus *Xerophyllum*, and includes three new species.

TABLE OF *XEROPHYLLUM* SPECIES.

1. Wings entirely explicate and extended more or less beyond the pronotal apex; foliaceous crest curvate, anteriorly substraight deflexed backward, posterior process lengthily extended backward beyond the apices of hind femora; length of pronotum, ♂ 14 mm.; ♀ 15 mm. . *extensum*, sp. nov.

1.1. Wings not entirely explicate, rarely reaching to and not beyond the pronotal apex; foliaceous crest semicircular or subreniform.

2. Anterior process of pronotum obtuse angulate, the crest regularly arcuate; anterior femora above nearly entire or somewhat sinuate, below undulate; lateral carinae of frontal scutellum compressed crenulate; wings extended nearly to the pronotal apex; length 19 mm. . . . *servillei*, Fairm.

2.2. Anterior process of pronotum subacute, crest largely elevated behind the middle; anterior femora above serrate, below

lobato-dentate ; wings covered by the sides of pronotum ; length of pronotum, ♂ 12 mm. . . . *simile*, Bol.

3. Pronotum behind at the apex incised, crest highly arched-cycloidal ; inferior margin of posterior femora strongly denticulate, inferior external carina bearing denticles ; length of pronotum, 12 mm. . . . . *platycorys*, Westw.

3.3. Pronotal apex obtuse-rounded, margin barely undate or subsinuate ; crest subreniform ; frontal scutellum cristate produced, entire or very slightly serrulate : vertex carina bearing a median projecting denticle ; posterior femoral carinae ventrally strongly quinquelobate, inferior external carina trilobate ; length of pronotum, ♂ 10.5 mm.; ♀ 11.5 mm. . . . . *cristifrons*, sp. nov.

4. Dorsal crest very highly compresso-elevated, semicircular, margin behind near the apex crenulate ; length of pronotum, ♂ 13 mm. . *galeatum*, Karsch, *fuscum*, Bol. (larva) ?

4.4. Dorsal crest very highly compresso-elevated, semicircular, but very little subangulate-rounded above the middle ; lateral carinae of frontal scutellum minutely spinulose ; length of pronotum, ♂ 11.5 mm. ; ♀ 11.8 mm. . . . . *nearei*, sp. nov.

X. extensum, sp. nov. (Plate XLIX, fig. 1.)

(See preceding synoptical table.) Lateral carinae of frontal scutellum minutely spinulose or denticulate. Pronotum highly elevated and strongly compresso-foliaceous, crest very thinly translucent bearing radiating veins; superior margin forward of the middle of dorsum regularly smoothly curvate, highly and roundly elevated subangulate behind the middle and extended deflexed backward substraight to the acute apex ; behind more than a third of

the posterior margin above minutely crenulate barely undate; the posterior process lengthily extended backward beyond the hind femora, a distance nearly equal to their length, the lateral margins below convex, anterior process in front curvate, apex bidentate, subobtuse, the inferior margin strongly oblique, substraight; lateral lobes posteriorly bisinuate. Elytra oblong; wings fully explicate, freely exposed at the sides and ends, and more or less distinctly extended beyond the pronotal apex, and beyond the hind femora a distance equal to their length. Femora subscabrous granulate, anterior femora foliaceous-dilate, superior carina serrulate, terminating in a small denticle, ventral margin serrulate-sublobulate; middle femora above serrulate-sublobate, inferior carina ampliate backwards toward the apex, serrate and incised bilobate; posterior femora externally scabrous, superior carina compresso-ampliate and serrate backwards terminating acutely, superior surface before the knees bearing two distinct fuscous spines, the inner one erect; external femoral carina thin, inconspicuous and minutely serrulate, the inferior external armed with two obscure minute denticles; ventral carina crenulate and somewhat distinctly quinquelobate. Colour greyish or greyish rufescent, the crest sometimes cinerous, subhyaline, and rarely marked with fuscous along the margin.

Length of pronotum, ♂ 14 mm.; posterior femora, 5.3 mm. ♀ pronotum, 15.5 mm.; posterior femora, 6 mm.

Seven examples; three males and four females from N.E. Rhodesia in the Oxford University Museum, collected by S. A. Neave in the following localities:—Two from Lofu River, 3500 ft., No. 2129, August 13, 1908; one from Chisinga Plateau, Kalangwini district, 4500 ft., September 25, 1908; three from Upper Kalangwisi Valley, 4200 ft., No. 2125, September 3, 1908, and one from Alala Plateau, Ndola district, 4000 ft., October 12, 1905.

This species may be a dimorphic long-wing form of *X. neavei.*

X. crisiifrons, sp. nov.

Frontal scutellum cristate produced, the margins between the antennae subentire or barely minutely serrulate, above slightly denticulate, median carina of vertex slightly crenulate, and bearing a distinct denticle projecting between the middle of the eyes. Pronotum strongly and thinly compressed foliaceous, bearing radiating veins; superior margin subreniform, forward before the middle flattened

arcuate, in front strongly roundly produced, behind the middle more largely elevated curvate, backward the margin at the apical fourth indistinctly quadri- or quinque-undate or subsinuate at the obtuse apex; superior margin rather widely longitudinally sulcate; anterior process subobtuse, the apex strongly bidentate, inferior lateral margins viewed from above strongly serrate, viewed from the side strongly oblique, substraight or little curvate produced over the head; pronotum posteriorly extended distinctly beyond the femoral apices; lateral lobes posteriorly bisinuate, the upper sinus very shallow, posterior angles strongly oblique, subobtuse and obliquely excised behind. Elytra oblong; wings not visible. Anterior femora compressed-foliaceous, superior carina serrulate-undate, below subquadrilobate, middle femoral carinae above compressed, serrulate-undulate, below strongly quadrilobate, or the two middle lobes fused in one, then trilobate; posterior femora rugose, superior carina crenulate (in the female bearing four tubercles), and the apex triangularly elevated; superior area before the knee bispinose, external pagina subtuberculate, as viewed from above the inferior external carina strongly trilobate, the first very small, ventral carina strongly quinque-lobate and finely serrate between the lobes. Colour rufescent, infuscate on the pronotum, the rest of body lighter.

Length of pronotum, ♀ 11·5 mm.; posterior femora, 5 mm. ♂ pronotum, 10·5 mm.; posterior femora, 4·3 mm.

Two examples from Abuthsi, River Niger, Africa (Rosenberg), in the author's collection.

X. neavei, sp. nov. (Plate XLIX, fig. 2.)

(See preceding table.) Lateral carinae of frontal scutellum minutely spinulose or denticulate. Pronotum subscabrous-granulate, highly elevated, very thinly compresso-foliaceous, sides bearing radiating veins, conspicuous when held against the light, superior margin of crest nearly semicircular, but very little subangulate-rounded above the middle, the anterior half regularly smoothly curvate, the edge above somewhat widely longitudinally sulcate, little planate, posterior half curvate, but the margin at the apical third part minutely crenulate, and here toward the apex slightly undate and little sinuate above the apex (more distinct in the female), anterior process subobtuse, the front border arcuate and the apex bidentate, and just above in front little denticulate; inferior lateral borders of anterior process strongly oblique, produced beyond the head, margin substraight, but viewed from above laterally serrate; posterior process extended backward little beyond the

apices of the hind femora; lateral lobes posteriorly bisinuate. Elytra oblong; wings very short, nearly completely covered by the sides of the pronotum, not reaching to apex of abdomen. Femora scabrous-granulate; anterior femora foliaceous dilate, dorsal margin serrulate, terminating in minute denticle; ventral margin serrulate, sublobate; middle femora above serrulate, subundulate, sinuate at the apex, below distinctly amplicate backward and serrate-lobate, being deeply bi-incised near the apex and distinctly lobate; posterior femora rugose-scabrous on the external pagina; superior margin strongly serrate, terminating in a denticle; superior areas before the knee bearing two fuscous acute denticles, the outer one less erect; ventral margin crenate quinque-lobate; the inferior external carina inconspicuous and minutely serrulate, often bearing minute tubercle near the middle. Colour greyish-fuscous or ferruginous, the superior margin of crest marked with fuscous.

Length of pronotum, ♂ 11·5 mm.; posterior femora, 5–5·5 mm. ♀ 11·8 mm.; posterior femora, 6 mm.

Four examples from N.E. Rhodesia in the Oxford University Museum, collected by S. A. Neave at the following points:—Three from Upper Kalungwisi Valley, 4200 ft., No. 2140, September 3, 1908; one from Chisinga Plateau, Kalungwisi district, 4500 ft., No. 2139, September 25, 1908.

One specimen has a singular abnormality in presenting a deep angulate incision excavated from the front part of the pronotal crest near the frontal apex. This individual seemingly was born with this peculiarity, and is possibly a mutation.

I take pleasure in dedicating this interesting species to S. A. Neave, who contributed the specimens to the Oxford University Museum.

Genus CLADORAMUS, Hancock.

Trans. Entom. Soc. London, p. 217, 1907.

As shown in the preceding synoptical table, this genus occupies a position midway between *Xerophyllum*, Fairm., and *Trachytettix*, Stål.

C. crenulatus, Hanc.

Six examples are represented in the present material collected and presented to the Oxford University Museum by S. A. Neave. They were taken at the following

points in N.E. Rhodesia:—Five from Chisinga Plateau, Kalungwisi, 4500 ft., No. 2149–2153, September 17, 1908, and one from Mporokoso, 4500 ft., No. 2154, September 2, 1908. The type female example from which the original description was drawn came from East Loangwa, Rhodesia.

Genus ACMOPHYLLUM, Karsch.

Entom. Nachrichten, p. 21, 1890.

In the preceding synoptical table of the genera of African *Cladonotae* I have classed both *Acmophyllum xerophylloides* and *A. conradti*, described by Bolivar, under the new genus *Medinophyllum*. The following table therefore is confined to the three remaining species enumerated below:—

TABLE OF SPECIES.

1. Inferior external carina of posterior femora quadrilobate; anterior margin of pronotal crest oblique, above before the middle summit flattened-undulate; length of pronotum, ♂ 16·3 mm.	*undulatum*, Karsch.
1.1. Inferior external carina of posterior femora distinctly unilobate at the middle.	
2. Anterior margin of pronotum vertical, above before the middle summit sinuate; length of pronotum, ♀ 17 mm.	*excavatum*, sp. nov.
2.2. Anterior half of pronotal margin above before the middle regularly rounded; length of pronotum, ♂ 18 mm.	*nigro-punctatum*, Bol.

A. excavatum, sp. nov.

Facial costa barely scutelliform, the lateral carinae entire, acute angulate above gradually divergent to the median ocellus, compresso-elevated between the antennae yet in profile flattened; face distinctly sinuate below at the ocellus; antennae inserted far below the eyes, equal in distance to one-half their height; vertex on each side next to the eyes bearing a small elevated tubercle. Pronotum

strongly compresso-foliaceous almost wholly cristate, more highly elevated above at the middle summit; the superior margin of anterior half abruptly elevated, in front vertical undate and above strongly unisinuate-subundate; the posterior half backward gently deflexed undulate and near the apex concave, posteriorly lengthily extended beyond the apices of the hind femora and acute; superior margin of crest marked with fuscous, viewed from above sinuous; anterior process below arcuate produced above the head, the apex little straight excised; lateral lobes of pronotum posteriorly bisinuate, posterior angles elongate, obliquely extended outward and rounded. Elytra oblong subacuminate; wings fully explicate, extended backwards to the pronotal apex. Anterior femora compresso-foliaceous, superior margin subtrilobate, below quadrilobate, or the two middle lobes fused in one; middle femoral carinae above slightly undulate, below compresso-ampliate, sinuate, and bearing a small apical lobe; posterior femoral carinae above subentire, minutely serrulate, marked by small fuscous dots, and near the apices terminating in acute denticle; inferior carina of external pagina strongly compressed-incrassate, viewed from above little undulate and bearing a strong projecting median lobe; ventral margin entire or indistinctly undulate and marked with fuscous; first articles of posterior tarsi equal in length to the third, the first and second pulvilli minute, the third distinctly longer. Colour, greyish-rufescent, sparingly speckled with fuscous, the tibiae infuscated toward the apices, joints and apices of tarsi black.

Length of pronotum, ♀ 17·2 mm.; height at middle, 7 mm.; posterior femora length, 7 mm.

Locality: Bitje Ja River, S. Cameroons (Rosenberg), in the author's collection.

Genus Rhopalotettix, nov.

Body smoothly granulose; eyes globose; face strongly retreating; vertex strongly obliquely produced in an elongate cephalic process, cuspidate at the apex, viewed from above longitudinally sulcate, sides entire; vertex, between the eyes forward broadly fossulate, middle not carinate. Antennae long, longer than the head, inserted below the eyes; frontal costa narrowly sulcate, superior paired ocelli placed between the lower third of the eyes; median ocellus placed far below the eyes. Pronotum anteriorly truncate, posteriorly lengthily acuminate-subulate, extended beyond the femoral apices; dorsum narrow between the shoulders, deplanate; median carina low, scarcely elevated; anterior carinae short parallel; humeral

angles nearly straight; posterior angles of the lateral lobes turned down obtuse, yet obliquely excised. Elytra small and widened posteriorly, apex widely rounded; wings perfectly explicate. Anterior femora strongly elongate, superior carinae basally compressed, acute and minutely serrulate; middle femoral carinae above compressed, terminating in an apical denticle; posterior femoral carinae above terminating in a denticle, below longitudinally curvate; genicular denticle produced; posterior tibiae narrow, the canthi minutely serrulate and bearing many small feeble denticles; first and third articles of posterior tarsi equal in length, the third joint distinctly clavate.

This genus resembles *Rhynchotettix*, Hancock,* but differs in the cuspidate apex of the produced cephalic process, in the absence of a median carina on vertex, in the prominent globose eyes, in the presence of elytra and wings, in the absence of a spine arming the posterior angles of the lateral lobes of pronotum, in the equal length of the first and third tarsal articles, and in the distinctly clavate form of the third joint of the posterior tarsi.

R. clavipes, sp. nov.

Body smooth granulate; eyes prominent and strongly globose; face strongly oblique; vertex strongly obliquely produced in an elongate cephalic process, in profile extended beyond the eyes more than the greatest length of one of them, in width equal to nearly two-thirds the height of one of the eyes, and terminating in a deflexed acute spine; process ventrally compressed, the middle forming the facial median carina above, basally sinuate between the lower part of the eyes; the process extension viewed from above narrower than the vertex backward, longitudinally sulcate, sides parallel entire but cuspidate at the apex; vertex between the eyes little narrowed forward, broadly transversely fossulate, nearly equal in width to one of the eyes, middle not carinate; superior paired ocelli placed between the lower third of the eyes; median ocellus situated far below the eyes, the distance from the median ocellus to the eyes much greater than the distance between the eyes; frontal costa narrowly sulcate, forked between the paired ocelli above, downwards compressed scarcely elevated; antennae long and slender, longer than the head, consisting of fourteen articles, the first basal articles crassate, second smaller globose, the next four

* Trans. Entom. Soc. London, p. 228, 1907.

short and indistinct, but the rest from the seventh to the terminal apical article strongly elongate. Pronotum anteriorly truncate, posteriorly lengthily acuminate-subulate extended beyond the hind femoral apices; dorsum deplanate, between the shoulders scarcely widened; humeral angles substraight, transversely subrounded; median carina percurrent but low barely elevated; anterior prozonal carinae short and parallel; lateral lobes of pronotum somewhat small, margin anteriorly arcuate; posterior angles turned down and obliquely excised. Elytra small, widened backward, the apices rounded, the central external two-thirds marked with black; wings perfectly explicate, extended barely beyond the pronotal apex. Anterior femora strongly elongate, superior margins little compressed basally and serrulate, below entire; middle femora elongate, superior carinae compressed minutely serrulate, and terminating in an apical spine, ventral carinae little compressed subentire or barely undulate; posterior femora slender, superior carinae forward arcuate, posteriorly terminating in distinct antegenicular denticle, very minutely serrulate, genicular apical lobe distinctly produced; ventral carinae slightly curvate, carinae of external paginae distinct and between them bearing oblique granulate rugae; posterior tibiae narrow, the canthi minutely serrulate and bearing many very small denticles; first and third articles of posterior tarsi equal in length; the third tarsal article distinctly clavate, the three pulvilli of the first tarsal article equal in length and obtuse below. Colour dark cinero-griseous, the hind tibiae infuscate, but light annulate behind the knees.

Entire length of body, ♀, 21·2 mm.; pronotum, 13·8 mm.; posterior femora, 6 mm.; hind tibiae, 5 mm.; antennae, 6 mm. One example in the author's collection.

Locality: Padang Pandjang, West Sumatra (Rolle).

This species is remarkable in the form of the long antennae, produced vertex, globose eyes, and clavate form of the third article of the posterior tarsi. Type in the author's collection.

Genus THORADONTA, Hancock.

Trans. Entom. Soc. London, p. 407, 1908.

This genus is represented by small forms with subquadrate vertex; elongate antennae inserted below the eyes; the pronotum anteriorly truncate, posteriorly abbreviated acuminate; with the median carina of pronotum sinuate or bicristate; dorsum widened between the obtuse

carinate humeral angles, and above bearing a supernumerary carinula on each side; the lateral lobes outwardly laminate, the posterior angle dentate or spined; elytra ovate and wings present; anterior and middle femora elongate, margins slightly compressed, above subentire, below undulate; the first and third articles of the posterior tarsi subequal or the first a little longer than the third, the first two pulvilli often acute subspiculate.

T. dentata, Hancock.

One female in the Oxford University, No. 269, from Selangor, Kuala Lumpur, Malay Peninsula, collected and presented by H. C. Pratt. The type in the Oxford University Museum is from Penang or Prince of Wales Island.

Genus Dasyleurotettix, Rehn.

Proc. Acad. Nat. Sci. Philadelphia, p. 68, 1904.

D. curriei, Rehn. (Plate XLIX, fig. 3.)

Ten examples, Nos. 2142–2148, from N.E. Rhodesia, in Oxford University Museum, collected and presented by S. A. Neave; nine from the Upper Kalungwisi Valley, 4200 ft., September 11, 1908; one from Chinsali, 4300 ft., April 11, 1908.

Genus Tetrix, Latreille.

Hist. Nat. Crust. Ins., vol. iii, p. 284, 1802.

T. bipunctata, Linné.

Two examples (varieties) in Oxford University Museum from Persian Gulf, (?) Bussorah.

T. subulata, Linné.

Two long-wing and one short-wing (varieties) in the Oxford University Museum from Persian Gulf, (?) Bussorah.

Genus Euparatettix, Hancock.

Spolia Zeylanica, vol. ii, p. 145, 1904.

E. interruptus, Brunner.

One ♀ example, No. 1106, from Malay Peninsula, S.W. Johore, Kukub, collected and presented by H. N.

Ridley to the Oxford University Museum. This specimen is nearly wholly black, the first and second legs banded with fuscous, while the black hind tibiae present a white annulation behind the knees.

E. pulvillus, sp. nov. (Plate XLIX, figs. 4 and 4*a*.)

A slender species allied to *Paratettix histricus*, Bol. Head exserted; vertex equal in width to one of the eyes, truncate, middle carinate, frontal costal in profile above little subangulate produced beyond the eyes, and between the antennae more subarcuate produced, rather narrowly sulcate. Pronotum punctate-granulate, constricted before the shoulders, and between the shoulders only slightly widened; anterior pronotal carinae short and parallel; median carina percurrent, compressed, slightly undulate forward and behind the shoulders, posterior process extended far beyond the femoral apices; posterior angles of the lateral lobes subacute. Elytra subovate and externally strongly reticulate; wings caudate extending beyond the pronotal apex two millimeters. Anterior and middle femora elongate, nearly entire, but the inferior carinae of middle femora scarcely undulate; posterior femora slender, superior carina serrulate terminating in a denticle before the knee, the external area at the middle plainly bituberculate; posterior tibiae ventrally infuscate and the apical fourth fuscous; first articles of posterior tarsi equal in length to the third, the first two basal pulvilli acute-spiculate, the third nearly as long as the first and second together, and flat below. Body below sparingly hirsute. Colour of body testaceous marked with black on the disk of the pronotum.

Entire length of body, ♀ 15 mm.; pronotum, 12 mm.; posterior femora, 5·5 mm.

One example from Malay Peninsula, Selangor, Riverside Estate, collected and presented to the Oxford University Museum by H. C. Pratt.

E. angustivertex, Bol.

Three examples from N.E. Rhodesia in the Oxford University Museum—two from Upper Kalungwisi Valley, 4200 ft., Nos. 2159 and 2163, September 11, 1908; one from Lofu River, 3500 ft., No. 2155, August 17, 1908, collected and presented by S. A. Neave.

Genus PARATETTIX, Bolivar.

Ann. Soc. Entom. Belgique, xxxi, p. 270, 1887.

P. pictus, sp. nov. (Plate XLIX, figs. 5 and 5*a*.)

Body small, coloured fuscous and light variegated. Head not exserted, dorsum above little rugose-granulate ; vertex little narrower than one of the eyes, little narrowed toward the front, viewed from above not produced beyond the eyes ; frontal costa in profile slightly projecting beyond the eyes above, but between the antennae subarcuate ; between the eyes indistinctly sinuate, the lateral rami moderately separated ; antennae inserted between the lower angles of the eyes ; eyes in profile subconoidal, the occiput covered. Pronotum anteriorly truncate, between the shoulders convex, little widened, posterior process subulate, extended beyond the femoral apices behind ; anterior prozonal carinae very short, quite widely separated and parallel ; median carina marked with fuscous, little compressed percurrent, subgibbulose near the front margin ; posterior angles of the lateral lobes rather obliquely excised. Elytra ovate ; wings caudate and black. Femora elongate, little compressed, margins entire and sparingly pilose ; middle femora in male narrowed toward the apices ; posterior femora elongate, margins minutely serrulate, antegenicular and genicular denticles prominent ; posterior tibiae black with white annulation behind the knees and marked with white at the distal third ; second and third posterior tarsal pulvilli subequal in length.

Entire length of body, ♂ 9·6 mm ; pronotum, 8 mm. ; posterior femora, 4 mm.

One example, No. 2158, from N.E. Rhodesia, Mporokosa, 4500 ft., August 31, 1908, collected and presented to Oxford University Museum by S. A. Neave. This species is nearly allied to *wilverthi*, Bolivar, differing in being more rugose, smaller in stature, in not being depressed behind the shoulders on the dorsum, and in the less depressed median carina behind the anterior border. It also differs in the equal length of the second and third posterior tarsal articles.

Genus PROTOTETTIX, Bolivar.

Ann. Soc. Entom. Belgique, xxxi, p. 255, 1887.

As I interpret the African genus *Prototettix*, Bol., there are three representatives, namely, *impressus*, Bol., *afri-*

canus, Hanc., and *bucculentus,* sp. nov., described below. The species *fossulatus,* Bol., and *lobulatus,* Stål, inhabiting South America, and formerly classed by Bolivar in this genus, are quite different from the African forms. As a result of a revised study of these insects the two latter species were recently transferred to my genus *Rytinatettix,* as noted in the Transactions of the Entomological Society of London, p. 416, 1908.

P. bucculentus, sp. nov. (Plate XLIX, figs. 6 and 6*a*.)

Colour shining, brownish fuscous, obscurely light variegated, sparingly sprinkled with various large tubercles. Body incrassate, head not at all exserted, occiput covered ; vertex transverse, rugose, twice the width of one of the eyes, frontal carinulae wanting ; in profile the distinct median crassate carina of vertex fused with the facial costa above, forming a rounded contour elevated above the eyes and strongly arcuately produced beyond them ; in front view widely sulcate, little divergent downward toward the median ocellus ; eyes conoidal in profile, the face below on each side tumid, antennae inserted barely between the lower angles of the eyes. Pronotum above rugose sprinkled with large tubercles, anteriorly convex ; dorsum very obtuse tectiform, barely impressed behind the shoulders ; anterior prozonal carinae low, little convergent backward ; humeral angles obtuse and indistinctly lineate carinate but the lateral carinae behind on the process more distinct, entire ; median carina acute, subpercurrent, arcuate anteriorly, depressed at the middle and subconvex backward toward the apex, posterior process abbreviated, subacute, not reaching to the knees of the hind femora ; lateral lobes rugose, inferior margin nearly straight, little sinuate, slightly reflexed outwards, posterior angles obliquely excised ; posterior superior sinus very small, nearly obsolete. Elytra small, narrow, subacuminate towards the apices ; wings not visible or wanting. Anterior femora elongate, above entire, below indistinctly unilobulate ; middle femora bicarinate, compressed, marginal carinae above aud below subtrilobulate ; posterior femora elongate, the outer area incrassate, marginal carinae above and below curvate, adorned with fuscous and minute flavous markings, minutely serrulate-granulate ; antegenicular denticle acute, genicular denticle wanting ; posterior tibiae incrassate, ampliate towards the apices, external canthi bearing many strong spines, and about seven spines arm the inner canthi ; tibiae black with small light annulation behind the knees ; the first hind tarsal articles incrassate, longer than the

third, all three pulvilli nearly equal in length and flat below, not at all acute.

Entire length of the body, ♀ 11·8 mm.; pronotum, 9 mm.; posterior femora, 6·5 mm.

One example, No. 2162, from N.E. Rhodesia, Upper Kalungwisi, 4200 ft., September 7, 1908; collected and presented to Oxford University Museum by S. A. Neave.

Genus Coptotettix, Bolivar.

Ann. Soc. Entom. Belgique, p. 289, 1887.

Owing to the incomplete descriptions of some of the species of African *Coptotettix*, the separation of the species is made difficult. I have attempted to give a revised table of the African species in the order in which they seem to be more readily recognized.

TABLE OF SPECIES.

1. Antero-dorsal margin of pronotum angulate
2. Body moderately crassate.
3. Antennae short, inserted between and towards the middle of the eyes, lateral carinae behind the anterior margin of dorsum obsolete; vertex obtuse-angulate, rounded produced before the eyes; third pulvilli of posterior tarsi longer than the second . . . . *angulatus*, Bol.
3.3. Antennae elongate, inserted between the lower part of the eyes; lateral carinae near the anterior margin of dorsum present, parallel; vertex rounded before the eyes; third and second pulvilli of posterior tarsi subequal in length . . . *minutus*, Bol.
2.2. Body narrower, rugose, legs shorter, posterior process extended far beyond the apices of posterior femora; wings barely passing pronotal apex; dorsum anteriorly covered with elongate rugae and bi-

rugate between the shoulders; elytra oblong, narrow, apices narrowly rounded . . . . . *discolor*, Bol.

1.1. Antero-dorsal margin of pronotum very slightly convex or truncate.

4. Antero-dorsal margin slightly convex; elytra rather wide, elongate, apices acutely angulate, externally lightly punctate impressed; first articles of the posterior tarsi little longer than the third, the third pulvilli longer than the first; pulvilli flattened below not at all spiculate . . . . *convexus*, sp. nov.

4.4. Antero-dorsal margin truncate.

5. Posterior pronotal process not abbreviated; wings extended to pronotal apex or caudate.

6. Median carina of pronotum percurrent, scarcely elevated, undulate, gibbulose anteriorly before the shoulders; dorsum sparingly rugulose and between the shoulders bearing elevated lines; posterior angles of lateral lobes widely rounded; vertex behind the fossae bearing distinct transverse placa; first pulvilli of posterior tarsi spinose . *bilineatus*, Bol.

6.6. Median carina of pronotum pluri-interrupted, scarcely elevated, dorsum covered with shining tubercles and short irregular lines; posterior process not or scarcely passing the apices of posterior femora; wings often caudate . . . . *annulipes*, Karsch.

5.5. Posterior process of pronotum not reaching to the apices of hind femora; wings shortened, hardly reaching to the abdominal apex.

7. Elytra oblong and black, anterior legs rufous	*rufipes*, Bol.
7.7. Elytra ovate; length of male pronotum 6 mm.	*parvulus*, Hanc.
	? *infuscata*, Walk. (not able to classify).

C. convexus, sp. nov. (Plate XLIX, figs. 7 and 7*a*.)

(See preceding table). Colour fusco-testaceous, hind femora of female often testaceous, of male variegated; vertex narrowed forward, scarcely wider than one of the eyes, middle carinate, on each side oblong fossulate, and bearing a transverse ruga behind; frontal carinulae roundly flexed backward each side of mid-carina, not projecting beyond the eyes; frontal costa arcuate produced before the eyes, viewed in front widest between the antennae; antennae inserted between the lower third of the eyes. Pronotum anteriorly barely convex, posteriorly lengthily subulate extended beyond the hind femoral apices; dorsum coarsely granulose, bearing small shining elongate tubercles, and bi-rugose, convex between the shoulders but behind the shoulders little subdepressed; subconcave backward on the process; median carina indistinctly undulate, scarcely elevated, subgibbulose between the sulci forward; lateral prozonal carinae forward low, granulate and parallel; humeral angles widely obtuse and scarcely distinct; posterior angles of lateral lobes oblique, apex subtruncate. Elytra rather wide, elongate, apices acutely angulate, externally lightly punctate impressed; wings fuscous or little testaceous, extended backward barely beyond the pronotal apex. Anterior and middle femora elongate, margins entire (more compressed in the male); posterior femora incrassate, externally rounded, granose, carinae above and below entire and subgranose; first articles of posterior tarsi little longer than the third, the third pulvilli longer than the first, the pulvilli flattened below not at all spinose.

Entire length, ♀ 13 mm.; pronotum, 11·8 mm; posterior femora, 6 mm. ♂ 12 mm.; pronotum, 10·5 mm.; posterior femora, 5·5 mm.

Four examples, Nos. 2156, 2157, 2160, and 2161, in the Oxford University Museum, from N.E. Rhodesia, Upper Kalungwisi Valley, 4200 ft., September 1908, collected and presented by S. A. Neave.

EXPLANATION OF PLATE XLIX.

[*See Explanation facing the* PLATE.]

Explanation of Plate XLIX.

Fig. 1. *Xerophyllum extensum*, sp. nov.; side view of body.

2. *Xerophyllum neavei*, sp. nov.; side view of body.

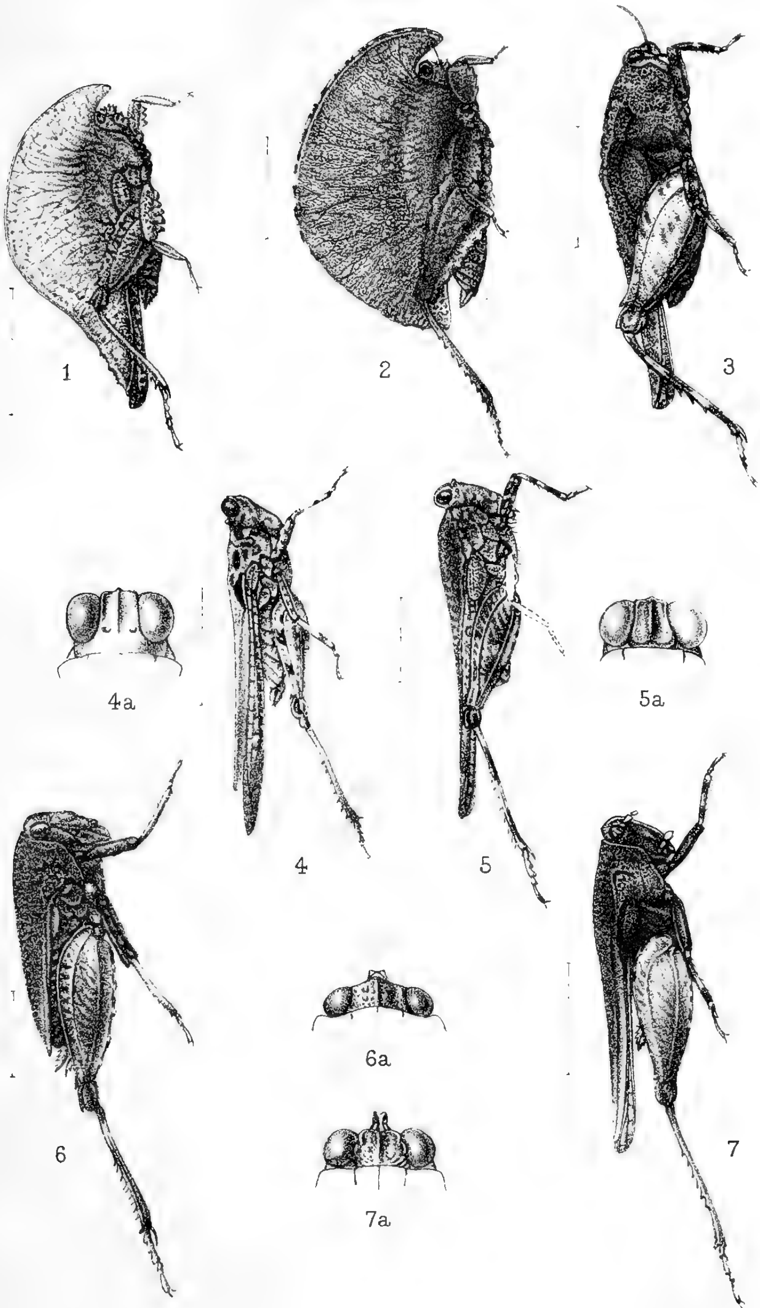
3. *Dasyleurotettix curriei*, Rehn; side view of body.

4. *Euparatettix pulvillus*, sp. nov.; side view of body; 4*a*, vertex of head from above.

5. *Paratettix pictus*, sp. nov.; side view of body; 5*a*, vertex of head from above.

6. *Prototettix bucculentus*, sp. nov.; side view of body; 6*a*, vertex of head from above.

7. *Coptotettix convexus*, sp. nov.; side view of body; 7*a*, vertex of head from above.



H. Knight del. West, Newman imp.

NEW SPECIES OF TETRIGINAE.

17

Ueberreicht vom Verfasser.

Blattidae.

By

R. Shelford.

Abdruck

aus den

Zoologischen Jahrbüchern.

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1910.

Blattidae.

By

R. Shelford.

The small collection of Blattidae which Prof. Dr. W. Kükenthal has been good enough to entrust to me for examination contains only 1 species which is new to science; the remaining species, 10 in number, have been previously recorded from various of the West-Indian islands with the exception of *Nyctibora noctivaga* Rehn and *Epilampra grisea* de Geer.

Subfam. *Phyllodromiinae.*

Ceratinoptera diaphana Fab.

Blatta diaphana Fabricius, Entomol. Syst., Vol. 2, p. 11 (1793).

2 ♂♂, 1 ♀, 1 larva.

St. Thomas. Previously recorded from St. Thomas, Cuba and Puertorico. The larva is testaceous, the thoracic tergites are patterned with castaneous and the abdominal tergites are banded with castaneous.

Subfam. *Nyctiborinae.*

Nyctibora noctivaga Rehn.

Nyctibora noctivaga Rehn, in: Trans. Amer. entomol. Soc., Vol. 29, p. 3 (1903).

1 ♂ larva.

St. Thomas, Loango. Previously recorded from Nicaragua.

Subfam. *Epilamprinae.*

Epilampra grisea (de Geer).

Blatta grisea de Geer, Mém. Ins., Vol. 3, p. 570, tab. 44, fig. 9 (1773).

1 ♂, 2 ♀♀, 3 larvae.

Trinidad. The species has a wide distribution on the South American continent.

Subfam. *Blattinae.*

Periplaneta americana (L.).

Blatta americana Linnaeus, Syst. Nat. (ed. 10), Vol. 1, p. 424 (1758).

3 ♂♂, 2 ♀♀, 4 ♂ larvae.

St. Thomas. A cosmopolitan species.

Periplaneta australasiae (Fab.).

Blatta australasiae Fabricius, Syst. Entomol., p. 271 (1775).

1 ♀.

St. Thomas, Loango. Another cosmopolitan species.

Stylopyga meridionalis Bruner.

Blatta (*Stylopyga*) *meridionalis* Bruner, in: Journ. New York entomol. Soc., Vol. 14, p. 141 (1906).

1 ♂.

Trinidad. Previously recorded from the same island.

Subfam. *Panchlorinae.*

Rhyparobia maderae (Fab.).

Blatta maderae Fabricius, Spec. Ins., Vol. 1, p. 341 (1781).

1 ♂, 1 ♀, 1 larva.

St. Thomas and Trinidad. This and the next species are cosmopolitan.

Leucophaea surinamensis (L.).

Blatta surinamensis Linnaeus, Syst. Nat. (ed. X), Vol. 1, p. 424 (1758)

3 larvae.

St. Thomas and Trinidad.

Panchlora nivea (L.).

Blatta nivea LINNAEUS, Syst. Nat. (ed. X), Vol. 1, p. 424 (1758).

1 ♂.

St. Thomas, Loango. The species ranges over the greater part of the Neotropical region.

Nauphoeta kükenthali n. sp.

♂. Green (white in alcohol). Vertex of head strongly exposed. Eyes rather wide apart. Antennae luteous. Pronotum sub-hexagonal, anteriorly sub-truncate, posteriorly very obtusely produced, sides slightly deflexed. Scutellum exposed. Tegmina exceeding the apex of the abdomen, mediastinal area cribrate-punctate, base of anal field seriate-punctate. Wings of equal length with tegmina, anterior part projecting considerably beyond posterior part, the outer margin notched at the junction of the two parts. Second abdominal tergite with a scent-gland opening, marked by two curved carinae diverging from a central papilla. Supra-anal lamina quadrate, its posterior margin faintly sinuate and triangularly notched in the middle. Sub-genital lamina of the usual form in this genus, symmetrical, posterior angles outwardly and backwardly produced, posterior margin rounded, slightly thickened and faintly hirsute, styles slender, situated in lateral notches. Cerci moderate, none of the apical joints enlarged. Femora with the formula of the apical spines $\frac{0}{1}, \frac{1}{1}, \frac{1}{0}$.

Total length 43 mm; length of body 36 mm; length of tegmina 34 mm; pronotum 9×13 mm. 1 ♂.

Loango near St. Thomas.

The unique specimen exhibits an interesting abnormality, the left posterior tarsus has only four joints, the third of which bears two pulvilli.

The genus *Nauphoeta* has not been recorded hitherto from the New World with the exception of the cosmopolitan species *N. cinerea* OLIV. The distinctions between the genera *Nauphoeta* and *Panchlora* are not well-marked and have apparently not been recognised with sufficient accuracy. Characters based on the form of the pronotum are extremely unsatisfactory and are often only of value for purposes of discriminating between species of the same genus, but taken in conjunction with other structural features they are of service. I have examined a good number of species of *Panchlora* and *Nauphoeta* and find that the genera can be discriminated as follows:

Panchlora.

Vertex of head almost covered by pronotum; pronotum posteriorly obtusely produced. Femora without any apical spines. Posterior metatarsus equal to or exceeding the length of the succeeding joints, its pulvillus apical. Sub-genital lamina (♂) asymmetrical. Colour some shade of green.

Nauphoeta.

Vertex of head more exposed. Pronotum usually less obtusely produced posteriorly. Either the mid- or hind-femora (sometimes both) with at least one apical spine. Posterior metatarsus shorter than succeeding joints, its pulvillus occupying the greater part of the joint. Sub-genital lamina (♂) symmetrical, posterior angles spinously produced outwards and backwards. Colour variable, frequently flavo-testaceous.

Adopting these criteria, which I believe to be reliable, we find that *Nauphoeta* is dominant in Africa, includes one cosmopolitan species, and has one representative, that just described, in the New World. *Panchlora* is dominant in the New World, includes one or two species that sporadically appear in Europe, and has three African representatives.

Panchlora smaragdina Br. (syn. *vitellina* Gerst.) and *P. adusta* Gerst. from West Africa, now fall into the genus *Nauphoeta*.

Subfam. *Blaberinae.*

Hemiblabera manca Sauss.

Hemiblabera manca Saussure, in: Soc. Entomol., Vol. 8, p. 68 (1893).

1 ♀.

St. Thomas. Previously recorded from Puertorico.

From the ANNALS AND MAGAZINE OF NATURAL HISTORY,
Ser. 8, Vol. vi., *July* 1910.

A new Cavernicolous Cockroach.

By R. SHELFORD, M.A., F.L.S.

Subfam. *CORYDIINÆ.*

ALLUAUDELLA, gen. nov.

Size minute. Antennæ elongate, setaceous. Palpi long and slender. Eyes reduced. Pronotum discoidal, anteriorly not covering vertex of head. Tegmina and wings considerably exceeding apex of abdomen, identical in texture and clothed with a delicate recumbent pubescence. Tegmina with mediastinal vein short, radial vein bifurcate from base, costals entirely absent, anterior ulnar simple, posterior ulna triramose, one vena spuria between the radial and anterior ulnar veins, anal vein straight, anal field much reduced, one

axillary vein. Wings with the mediastinal vein short, radial vein simple, costals entirely absent, median vein bifurcate from base, ulnar bifurcate, two venæ spuriæ, posterior part of wing reduced to a small lobe with one curved axillary vein. Legs long and very slender; femora with genicular spines; posterior tibiæ with a few minute spines on the outer aspect, biseriately arranged; posterior metatarsus much exceeding in length the following joints. No tarsal arolia.

Fig. 1.

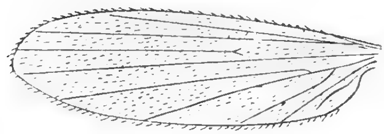


Fig. 2.

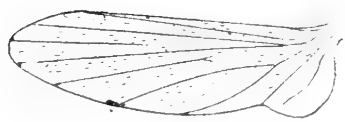


Fig. 3.

Fig. 4.

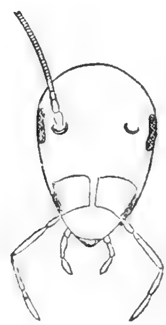


Fig. 1. Left tegmen. Fig. 2. Left wing. Fig. 3. Hind leg. Fig. 4. Head from below.

Alluaudella cavernicola, sp. n.

♂. Pale flavo-testaceous, impunctate. Frons not bullate. Eyes and antennal sockets situated low down on the frons, the former reduced to a pair of slender streaks. Supra-anal

lamina trapezoidal, its apex faintly emarginate. Subgenital lamina deeply and widely cleft at the apex, the angles produced, each bearing a minute style. Posterior tibiæ longer than their femora. (Cerci mutilated.)

Length of body 3·5 mm.; length of tegmina 4·5 mm.

Kulumusi caves, near Tanga, German East Africa (*M. Ch. Alluaud*, 1909). Types in Paris and Oxford University Museums.

This remarkable genus, belonging to the *Latindia* section of the subfamily, agrees with *Cardax* mihi, from Ceylon, in the pubescent tegmina and wings, the radiate arrangement of their veins, the reduction of the posterior field of the wings.

From the Annals and Magazine of Natural History,
Ser. 8, Vol. vii., *July* 1911.

Descriptions of some new Species of Blattidæ.

By R. Shelford, M.A., F.L.S.

[Plate I.]

Hemithyrsocera testacea, sp. n.

♂. Rufo-testaceous, head darker. Pronotum trapezoidal, margined anteriorly and laterally with opaque testaceous. Tegmina extending slightly beyond the apex of the abdomen; 15 costals, radial vein bifurcate from near the base, 7 longitudinal discoidal sectors, anterior ulnar 3-ramose. Wings hyaline; veins flavous, mediastinal vein 3-ramose, radial vein bifurcate from near base; 9 costals, the first six incrassated, ulnar simple, triangular apical area not very conspicuous. Supra-anal lamina triangular, not exceeding the subgenital lamina, which is asymmetrical, slightly produced, with one minute style (the right), and one larger, hidden under the lamina. Opening of scent-gland on seventh abdominal tergite. Legs testaceous, tibiæ tipped with fuscous; front femora with a complete row of spines beneath, the more distal short.

Total length 13 mm.; length of body 12 mm.; length of tegmina 11 mm.; pronotum 3×4 mm.

Erythræa, Ghinda, Cheren.

Type in Oxford University Museum.

Ischnoptera lunaris, sp. n.

♂. Pale testaceous. Head with a broad castaneous stripe extending from between the eyes to the clypeus; vertex testaceous, occiput castaneous. Antennæ testaceous. Pronotum trapezoidal, a castaneous vitta on each side of the disc, the vittæ narrowly contiguous anteriorly. Tegmina with a narrow castaneous vitta extending from the base of the radial vein throughout three-fifths of the costal field; radial vein bifurcate, about 15 costals, 8 longitudinal discoidal sectors, both ulnar veins ramose. Wings hyaline, mediastinal vein 3-ramose, radial vein bifurcate, about 8 costals; ulnar vein 6-ramose, 4 rami being incomplete; a moderately prominent apical triangle. Abdomen testaceous; supra-anal lamina transversely quadrate, its posterior margin sinuate; subgenital lamina exceeding the supra-anal lamina, asymmetrical, its apex produced to form a minute lobe curved upwards and inwards and beset with setæ; one minute style (the left). Cerci moderate, testaceous. Legs testaceous; front femora with a complete row of spines on the anterior margin beneath.

Total length 14 mm.; length of body 11 mm.; length of tegmina 12 mm.; pronotum 2·5×4 mm.

Queensland, Peak Downs (*Godeffroy*). Two examples only.

Allied to *Ischnoptera manicata*, Tepper.

Type in the Stockholm Museum.

Ischnoptera jocosa, sp. n.

♂. Head piceous or dark castaneous; genæ, ocelli, and mouth-parts testaceous. Antennæ infuscated. Pronotum trapezoidal, piceous, margined all round with testaceous, more narrowly anteriorly and posteriorly than laterally. Tegmina pale castaneous, outwardly margined with testaceous, base of principal veins dark castaneous; radial vein bifurcate, about 14 costals, 7–8 longitudinal discoidal sectors. Wings hyaline; mediastinal vein ramose, radial vein bifurcate; 8 costals with incrassated apices; ulnar vein with 3–4 rami, 1 being incomplete; a small and ill-defined apical triangle. Abdomen rufo-castaneous. Supra-anal lamina trigonal, apex notched; subgenital lamina almost symmetrical, apex faintly emarginate and furnished with one sharply pointed style

curved upwards and backwards. Cerci infuscated. Legs testaceous; front femora with a complete row of spines on anterior margin beneath.

♀. Similar, but supra-anal lamina sharply triangular, apex not emarginate, surpassed by the semiorbicular, ample subgenital plate.

Total length 11 mm.; length of body (♂) 8, (♀) 7 mm.; length of tegmina 8·5 mm.; pronotum 2·5 × 3 mm.

Queensland, Peak Downs (*Godeffroy*). Three specimens.

Types in the Stockholm Museum.

This species is transitional to the genus *Blattella*, Caud., as typified by *B. germanica*, L., but on account of the incomplete ramus of the vena ulnaris alarum I prefer to place it in *Ischnoptera*.

Mareta scripta, sp. n.

♂. General colour sordid testaceous. Head with a band between the eyes, two lines on the frons, and two spots just above the clypeus castaneous. Antennæ pale testaceous at base, remainder infuscated. Pronotum transversely elliptical, lateral margins broadly hyaline, disc with castaneous dots and lines arranged in a symmetrical pattern. Tegmina and wings exceeding the apex of the abdomen. Tegmina with all the veins bordered with quadrangular spots of pale brown; radial vein simple, 13 costals, discoidal sectors numerous, oblique, posterior ulnar simple. Wings hyaline; mediastinal vein biramose; 8 costals, the more proximal with incrassated apices, the first crossing the lower mediastinal branch; ulnar vein 4- to 5-ramose; an inconspicuous apical triangle. Supra-anal lamina transverse; subgenital lamina produced at the apex into a lobe terminating in two styliform processes, the genital styles situated on either side of this lobe. Cerci and legs testaceous, the former fusco-maculate towards apex.

Total length 11 mm.; length of body 7·5 mm.; length of tegmina 9 mm.; pronotum 2 × 3 mm.

Queensland, Peak Downs (*Godeffroy*). Three specimens.

Type in the Stockholm Museum.

Owing to the structure of the subgenital lamina the male looks as if it had four genital styles. Superficially the insect resembles *Phyllodromia ceylonica*, Br. (synonyms, *P. punctulata*, Br., *P. nimbata*, Shelf.), but the structural characters of alary organs and femora establish its generic identity as here given. The colouring of the tegmina, moreover, is quite characteristic of *Mareta*.

Mareta godeffroyi, sp. n.

♀. Head piceous, mouth-parts castaneous. Antennæ castaneous at base, remainder piceous. Pronotum trapezoidal, sordid testaceous, with two broad, irregular, castaneous vittæ; a small testaceous spot situated in the outer border of each vitta. Tegmina and wings exceeding apex of abdomen. Tegmina testaceous, with all the intervenular spaces filled with castaneous; marginal area very broad, radial vein simple; 13 costals, the last two multiramose; discoidal sectors oblique, posterior ulnar simple. Wings with the veins fuscous; mediastinal vein anastomosing at apex with the first costal, radial simple; 9 costals, their apices clavate; ulnar vein with 4 rami; apical triangle inconspicuous. Abdomen above and beneath rufo-castaneous, heavily bordered with piceous; supra-anal lamina triangular, apex deeply notched; subgenital lamina semiorbicular, ample. Cerci piceous, 13-jointed. Legs rufo-testaceous, suffused with darker.

Total length 12 mm.; length of body 11 mm.; length of tegmina 11 mm.; pronotum 3 × 5 mm.

Queensland, Peak Downs and Gayndah (*Godeffroy*). Two examples.

Type in the Stockholm Museum.

Closely allied to *Mareta subtilis*, Brunn. (= *Phyllodromia subtilis*). It may be noted here that the chief diagnostic characters of the genus *Mareta*, Bol., are the oblique discoidal sectors of the tegmina, the ramose ulnar vein of the wings, an inconspicuous apical triangle, and the front femora with the anterior margin beneath armed only with close-set setæ.

Stylopyga immunda, sp. n.

♂. Piceous, nitid. Labrum ochreous. Antennæ castaneous. Tegmina lobiform. Seventh abdominal tergite triangularly produced, almost concealing the supra-anal lamina, which is subtriangular, with the apex produced to a point; the margins of the lamina are serrated. Subgenital lamina quadrate, with two stout genital styles. Cerci flattened, acuminate. Legs with the femora castaneous; second posterior tarsal joint armed, the other joints unarmed, their pulvilli large; tarsal arolia present.

♀. Similar, but the seventh abdominal tergite less strongly produced; supra-anal lamina posteriorly concavely emarginate.

Total length, (♂) 27, (♀) 26 mm.; pronotum (♂ ♀) 9–10 × 12 mm.

Queensland. Three specimens.

Type in the Stockholm Museum.

Allied to *S. coxalis*, Walk., from Ceram and New Guinea, but differing in the form of the supra-anal lamina of the male.

Stylopyga proposita, sp. n. (Pl. I. fig. 1.)

♂. Piceous, nitid. Labrum and clypeus castaneous; palpi piceous. Antennæ castaneous. Tegminal rudiments absent. Seventh abdominal tergite obtusely produced. Supra-anal lamina sharply triangular, surpassing the subgenital lamina, which is rounded, sides not notched; styles straight, spiniform. Cerci flattened, moderate. Posterior metatarsus longer than succeeding joints; all the pulvilli minute, apical; arolia absent.

♀. Similar, but supra-anal lamina obtusely produced, apex truncate.

Total length (♂ ♀) 24 mm.; pronotum 7·5 × 10 mm.

Java, Batavia, Tanah-Abang (*P. Serre*, 1904). Two examples.

Types in the Paris Museum.

Stylopyga maindroni, sp. n.

♂. Head piceous, with the mouth-parts castaneous; antennæ piceous at base, remainder fuscous. Thoracic tergites rufo-castaneous; pronotum heavily bordered with piceous; a triangular piceous blotch on each side of the meso- and metanotum. No tegminal rudiments. Abdomen above dark castaneous at base, becoming piceous towards the apex. Seventh abdominal tergite obtusely produced. Supra-anal lamina bluntly triangular. Abdomen beneath rufous, margined with piceous. Subgenital lamina rounded; styles straight, not spiniform, rufous. Cerci flattened, piceous. Legs rufous. Posterior metatarsus equal in length to the succeeding joints, second tarsal joint armed beneath; pulvilli of moderate size; arolia absent.

Total length 18 mm.; pronotum 6 × 7·5 mm.

Nilghiris, Coonoor (*Maindron*, 1902). One example.

Type in the Paris Museum.

The Oriental and Australian species of the genus *Stylopyga*, as defined by me in Gen. Insect., Blattidæ, Subfam. Blattinæ, fasc. 109 (1910), can be distinguished by the following

synoptical key. The well-known and cosmopolitan species *S. rhombifolia*, Stoll, and the gaudy *S. ornata*, Br. (figured in the above-cited memoir), are omitted.

1. Wings represented by squamiform lobes.	
2. Unicolorous species	*quadrilobata*, Br. (Celebes.)
2′. Pronotum and tegminal rudiments margined with ochreous	*salomonis*, Shelf. (Solomon Is.)
1′. Wings entirely absent.	
2. Tegminal rudiments present.	
3. Thorax and abdomen above with rufous maculæ	*sex-pustulata*, Walk. (S. India, ? Java.)
3′. Unicolorous species.	
4. Tegminal rudiments transversely truncate, almost square	*picea*, Br. (Nicobar Is.)
4′. Tegminal rudiments with apex rounded, elliptical.	
5. Pulvillus of second joint of posterior tarsus small, apical	*semoni*, Kr. (Java.)
5′. Pulvillus of second joint of posterior tarsus larger, occupying half the joint	*immunda*, sp. n. (Queensland.)
2′. Tegminal rudiments absent.	
3. Unicolorous species.	
4. Coxæ not margined with testaceous.	
5. Pulvilli of posterior tarsus minute, apical	*proposita*, sp. n. (Java.)
5′. Pulvilli large, occupying the greater part of the tarsal joints	*parallela*, Bol. (S. India.)
4′. Coxæ margined with testaceous.	
5. Seventh abdominal tergite strongly produced backwards, almost hiding the supra-anal lamina....	*coxalis*, Walk. (Ceram, New Guinea.)
5′. Seventh abdominal tergite scarcely produced	*michaelseni*, Shelf.* (W. Australia.)
3′. Body above anteriorly rufo-castaneous, posteriorly piceous	*maindroni*, sp. n. (S. India.)

Stylopyga togoensis, sp. n. (Pl. I. fig. 2.)

♂. Piceous, nitid, impunctate. Antennæ castaneous, mouth-parts testaceous. Tegmina represented by squamiform lobes, scarcely extending beyond the mesonotum. Posterior angles of abdominal tergites scarcely produced, seventh tergite shortly produced; supra-anal lamina shortly trigonal, exceeded by the subgenital lamina, which is subquadrate and produced, its apex slightly emarginate. Genital styles bifurcate; the outer limb long, curved, and flattened, the inner

* Accidentally omitted from my Gen. Insect. memoir. The reference is:—Blattidæ [*in*] Fauna S.W.-Australiens (Michaelsen & Hartmeyer), Vol. ii. Lfg. 9, p. 140 (1909).

limb short and terminating in four teeth. Cerci stout, 10-jointed. Legs castaneous; posterior tarsi elongate, the second joint spined beneath.

Length 13 mm.; pronotum $5{\cdot}1 \times 6$ mm.

Togo, Misahöhe (*E. Baumann*).

Type in the Berlin Museum.

Blatta rufo-cercata, sp. n.

♀. Piceous. Pronotum with an elongate rufous macula on each lateral margin. Tegmina subquadrate, obliquely truncate, sutural margins touching, just reaching the first abdominal tergite, seriate-punctate. Scutellum not exposed. Wings minute, lobiform, completely hidden by the tegmina. Seventh abdominal tergite obtusely produced, margin not sinuate. Supra-anal lamina cucullate, subtruncate. Cerci short, rufous. Femora rather sparsely armed; tarsi rufo-castaneous, their structure quite typical of the genus; arolia absent.

Total length 15 mm.; length of tegmina 3 mm.; pronotum 4×6 mm.

Manila (*Leveillé*, 1877). Two examples.

Type in the Paris Museum.

Pseudoderopeltis morosa, sp. n.

♂. Head castaneous, antennæ fuscous. Pronotum piceous, trapezoidal, with two oblique impressions; membranous processes of meso- and metanotum moderately long and slender. Tegmina castaneous, considerably exceeding the apex of the abdomen. Wings suffused with castaneous, median vein bifurcate and ramose; a small intercalated apical triangle. Abdomen piceous; supra-anal lamina trigonal, subgenital lamina rounded, styles long and slender. Legs castaneous.

♀. Piceous, nitid, impunctate. Clypeus testaceous; antennæ rufescent. Tegminal rudiments barely extending beyond the mesonotum. Posterior angles of abdominal tergites 5–7 produced, seventh tergite with posterior margin very convex; supra-anal lamina cucullate, triangular, emarginate. Legs castaneous; posterior tarsi rather short, second joint not spined beneath, its pulvillus large.

♂. Total length 25 mm.; length of body 19 mm.; length of tegmina 21 mm.; pronotum 6×7 mm.

♀. Length of body 21 mm.; length of tegmina 4 mm.; pronotum 6×9 mm.

Chinchoxo (*Falkenstein*). Several examples.

Types in the Berlin Museum.

Pseudoderopeltis togoensis, sp. n.

♂. Very like *P. morosa*, but smaller; pronotum castaneous; membranous processes of meso- and metanotum obsolescent; tegmina paler towards apex; median vein of wings not bifurcate, anastomosing irregularly with the radial vein; no intercalated triangle; supra-anal lamina more produced, apex slightly emarginate.

Total length 22 mm.; length of body 16 mm.; length of tegmina 18 mm.; pronotum 4·5 × 6 mm.

Togo, Bismarckburg (*R. Büttner*). Several examples.

Type in the Berlin Museum.

Euthyrrapha vittata, sp. n. (Pl. I. fig. 3.)

♀. Body and head piceous, with sparse erect pubescence. Antennæ piceous. Tegmina castaneous, with a broad orange vitta extending from the base to near the apex. Wings hyaline, with the apex castaneous and an orange stigma on the costa; ulnar vein with 6 rami. Supra-anal lamina subquadrate; subgenital lamina ample, with the apex deeply cleft. Cerci slender, acuminate. Legs castaneous, the tibial spines rufous.

Length of body 6 mm.; length of tegmina 5 mm.; length of wings 7 mm.; pronotum 2 × 3 mm.

N. Kamerun (*Conradt*).

Type in the Berlin Museum.

Holocompsa capsoides, sp. n. (Pl. I. figs. 6 *a*, 6 *b*.)

♂. Piceous, with a scant, recumbent, rufous pubescence. Mouth-parts castaneous. Pronotum trapezoidal; scutellum exposed, conspicuous. Wings in repose extending somewhat beyond the tegmina. Tegmina with the mediastinal and anal areas, a space between them, and a triangular patch (the base of the triangle extending from the apex of the anal area to the apex of the mediastinal area, its apex at a point situated halfway on the outer margins of the tegmen) coriaceous, the remainder of the tegmen membranous, hyaline, with a fuscous suffusion at the apex; mediastinal and anal veins conspicuous, the other veins obsolescent or absent. Wings hyaline, with the posterior margin broadly suffused with fuscous; a large fuscous stigma on the anterior margin formed by a fusion of the mediastinal rami and of the proximal costals; the bases of the ulnar and first axillary veins are moderately robust, otherwise the venation of the wing is obsolescent. Supra-ana lamina shortly trigonal,

surpassed by the subgenital lamina, which is trapezoidal and furnished with two slender styles. Cerci slender. Legs castaneous.

Total length 6·2–7 mm.; length of tegmina 5–5·6 mm.; pronotum 1·8 × 2·5 mm.

Lower Ogowé, between Lambarene and the sea (*E. Haug*, 1901). Two examples.

Type in the Paris Museum.

Allied to *H. minutissima*, de Geer, but distinguished *inter alia* by the obsolescent venation.

Genus Nymphrytria, nov.

Form semiglobular. Antennæ extremely short, incrassated; the first joint elongate, equal to one-quarter of the total length of the antennæ, the second and third joints as long as broad, the remaining joints transverse. Frons above the clypeus bullate. Body fringed with long stiff hairs. Pronotum anteriorly produced strongly, completely covering the head, posterior margin convex. Posterior angles of seventh abdominal tergite acutely produced. Cerci minute, hidden, unjointed. Posterior tibiæ subquadrangular, the spines on the outer aspect biseriately arranged, those on the inner aspect uniseriately arranged; the spines serrated and grooved. Tarsi slender, fimbriate, without pulvilli and without claws.

Nymphrytria mirabilis, sp. n. (Pl. I. fig. 4.)

♀. Pale testaceous, tibial spines castaneous. Antennæ with 32 joints. Eyes wide apart. Hairs fringing the body testaceous. Pronotum finely granulate and with a few minute hairs; disc with two transverse impressions and a faintly impressed median line. Meso- and metanotum and the first three abdominal tergites smooth, nitid. Abdominal tergites 4–6 finely granulate in the middle. Supra-anal lamina rounded, margin entire, surpassing the subgenital lamina, which is semiorbicular, its posterior margin indented on either side, the tuberculiform cerci visible in the notches. Femora and tibiæ short and robust, tarsi slender. Femora armed on both margins beneath with a few minute spines, the spines at the apical angles arranged in little groups of 3 or 4; no genicular spines. Front tibiæ very short, with 8 apical spines and 1 free spine, the longest spine not equal to the length of the first tarsal joint; mid tibiæ with 7 spines on the outer aspect, biseriately arranged, 5 apical spines, no spines on the inner aspect, the longest apical spine equal in length to the tibia, but not so long as the first tarsal joint;

hind tibiæ quadrangular, flattened from side to side, broader at the apex than at the base, 6 spines on the outer aspect biseriately arranged, 4 long spines in a single row on the inner aspect near the apex, 5 apical spines, the longest of which is not quite equal to the first tarsal joint. Tarsi slender, the metatarsi exceeding in length the remaining joints, fimbriate and entirely without pulvilli or claws.

Length 12 mm.; greatest breadth 10 mm.; pronotum 6×8 mm.

Tunis, Gafsa.

Type in the St. Petersburg Museum.

This highly remarkable species is an extreme development of the genus *Anisogamia*, Sauss.; it resembles that genus in the form and fimbriation of the body, in the length of the first antennal joint, in the concealed and rudimentary cerci, and, to a certain extent, in the armature of the femora. It differs from *Anisogamia* by the extremely short antennæ, by the form of the pronotum, by the femoral armature, and by the simplification of the tarsal structure. The pronotum of *Nymphrytria* in its shape resembles that of the males of *Polyphaga* species in its anterior production. The tarsal structure is unique amongst the Blattidæ, and it would be interesting to learn if its simplification and the serration of the tibial spines are correlated with peculiar habits of life; that the species, like most of the *Polyphagæ*, has burrowing habits is sufficiently indicated by the structure of the fore tibiæ, which, as digging instruments, must rival in efficiency those of *Gryllotalpa*.

Polyphaga platypoda, sp. n. (Pl. I. fig. 5.)

♀. Rufo-castaneous, rufo-fimbriate. Antennæ short and somewhat incrassated, with 36–40 joints, the apical of which are moniliform. Pronotum slightly produced anteriorly, completely covering the head, together with the meso- and metanotum granulate and with a sparse erect pubescence; disc with chiselled markings. Abdomen smooth, nitid. Supra-anal lamina subtransverse. Subgenital lamina and cerci as in the preceding genus. Legs short, robust. Femora with a few minute spines on both margins beneath; no genicular spines. All the tibial spines robust, grooved beneath, and finely serrated. Front tibiæ as in the preceding species; mid tibiæ with spines on the outer aspect triseriately arranged, none on the inner aspect, 5 apical spines, the longest not equal to the first tarsal joint; hind tibiæ curved, spines on the outer aspect triseriately arranged in two groups,

3 spines on the inner aspect arranged in a single oblique row, 7 apical spines, the longest exceeding in length the first tarsal joint. Tarsi elongate, the metatarsi of the first and second pairs of legs flattened and grooved, considerably exceeding in length the succeeding joints ; the second to fourth joints of the mid tarsi also grooved and flattened ; the posterior metatarsi not grooved, shorter than the first and second pairs. Claws slender, without arolia.

Length 16 mm.; greatest breadth 11 mm.; pronotum 6·5 × 8·1 mm.

Tunis, Gafsa.

Type in the St. Petersburg Museum.

A singular species, belonging to the same group as *P. africana*, L., but differing in the peculiar tarsal structure and in the single row of spines on the inner aspect of the hind tibiæ, a character also presented by the genera *Anisogamia* and *Nymphrytria*.

Chorisoneura australica, sp. n.

♀. Form ovate, depressed. Head very flattened, frons highly polished; testaceous. Antennæ pale testaceous. Pronotum hyaline, with two broad rufescent vittæ ; very broad in proportion to length, anteriorly broadly emarginate, so that the vertex of the head is freely exposed, posteriorly truncate, exposing the small testaceous scutellum. Tegmina and wings not exceeding apex of abdomen. Tegmina with very broad hyaline marginal area, disc rufescent; mediastinal vein very robust, extending throughout two-fifths of the tegmen-length, but failing to reach the outer margin, the first three costals abutting on it; radial vein simple, 9 costals, 1 ulnar vein with 4 oblique rami, the discoidal and anal areas reticulated. Wings hyaline ; radial vein curved ; 10 costals, all rising from the posterior third of the radial vein, their apices incrassated, forming a conspicuous " stigma " ; medio-discal area twice as broad as medio-ulnar area, crossed by a few transverse venules; ulnar vein biramose, the rami united by anastomoses ; a large apical area, its base acutely angulate, in repose folded on the top of the wing. Abdomen rufescent above, testaceous beneath, broad; supra-anal lamina triangular, deeply incised at the apex; subgenital lamina ample, posterior margin widely and faintly emarginate. Cerci long, rufo-testaceous. Legs testaceous.

Total length 8 mm.; length of tegmina 6·5 mm.; pronotum 2 × 3·8 mm.

Queensland, Cape York (*Thorey*) ; Rockhampton, Gayndah (*Godeffroy*). Five specimens.

Type in the Stockholm Museum.

The ootheca is chitinous and carried with the suture uppermost.

Chorisoneura delicatula, sp. n.

♀. Allied to the preceding species, but much larger and differing in the following points:—Colour pale testaceo-hyaline, disc of pronotum opaque testaceous. Pronotum anteriorly less conspicuously emarginate. Tegmina with bases of mediastinal and radial veins opaque testaceous, some of the intervenular spaces filled with rufo-testaceous; mediastinal vein longer, 16–18 costals, 6 or 7 abutting on the mediastinal vein; ulnar vein with 9 oblique rami. Wings with 14 costals, not forming a "stigma."

Total length 11 mm.; length of body 7·5 mm.; length of tegmina 8·5 mm.; pronotum 3 × 4·8 mm.

Queensland, Peak Downs (*Godeffroy*), and Cape York (*Thorey*). Two examples.

Type in the Stockholm Museum.

The genus *Chorisoneura*, Br., is here recorded for the first time from Australia; originally regarded as purely Neotropical, recently its range has been shown to extend into West Africa and the Indian subregion. It is possible that when the genus has been thoroughly revised it will be necessary to separate off the two Australian species under a different generic name, for they differ somewhat from the extra-Australian species; but, pending such a revision, they may be regarded as outlying members of the rather loosely defined genus *Chorisoneura*.

Blabera lindmani, sp. n.

♂. Allied to *B. immacula*, Sauss. & Zehnt., from Pernambuco. Head piceous, frons not flattened, interspace between eyes about equal to the length of the first two antennal joints. Pronotum unicolorous castaneous, striated anteriorly and posteriorly; disc with a few impressions; form similar to that of *B. immacula*. Tegmina pale fuscous, bases of the mediastinal and radial veins darker. Wings hyaline, with marginal area narrowly testaceous, outer margin sinuate. Abdomen above wood-brown, beneath rufescent margined with castaneous. Supra-anal lamina bilobate; subgenital lamina slightly asymmetrical, notched on the right side, two styles. Cerci very short. Legs castaneous; femora entirely unarmed beneath, formula of apical spines $\frac{0}{2}$, $\frac{1}{1}$, $\frac{1}{0}$, front

femora with no genicular spines; posterior metatarsi short, unarmed, all the pulvilli very large; no arolia between the tarsal claws.

Total length 42 mm.; length of body 32 mm.; length of tegmina 32 mm.; pronotum 10 × 14 mm.

Brazil (*C. Lindman*). One example only.

Type in the Stockholm Museum.

Panesthia froggatti, sp. n.

♀. Allied to *P. kheili*, Bol., and with almost identical pronotal structure, but tegmina and wings reduced to squamiform rudiments, their apices obliquely truncate. Outer margins of seventh abdominal tergite faintly crenulate, the apical tooth directed outwards as well as backwards; margin of supra-anal lamina dentate.

Total length 37 mm.; length of tegmina 7·2 mm.; pronotum 10 × 14 mm.

Solomon Islands (*W. W. Froggatt*).

Type in Oxford University Museum.

EXPLANATION OF PLATE I.

Fig. 1. Apex of abdomen of *Stylopyga proposita*, sp. n., ♂. Dorsal aspect.

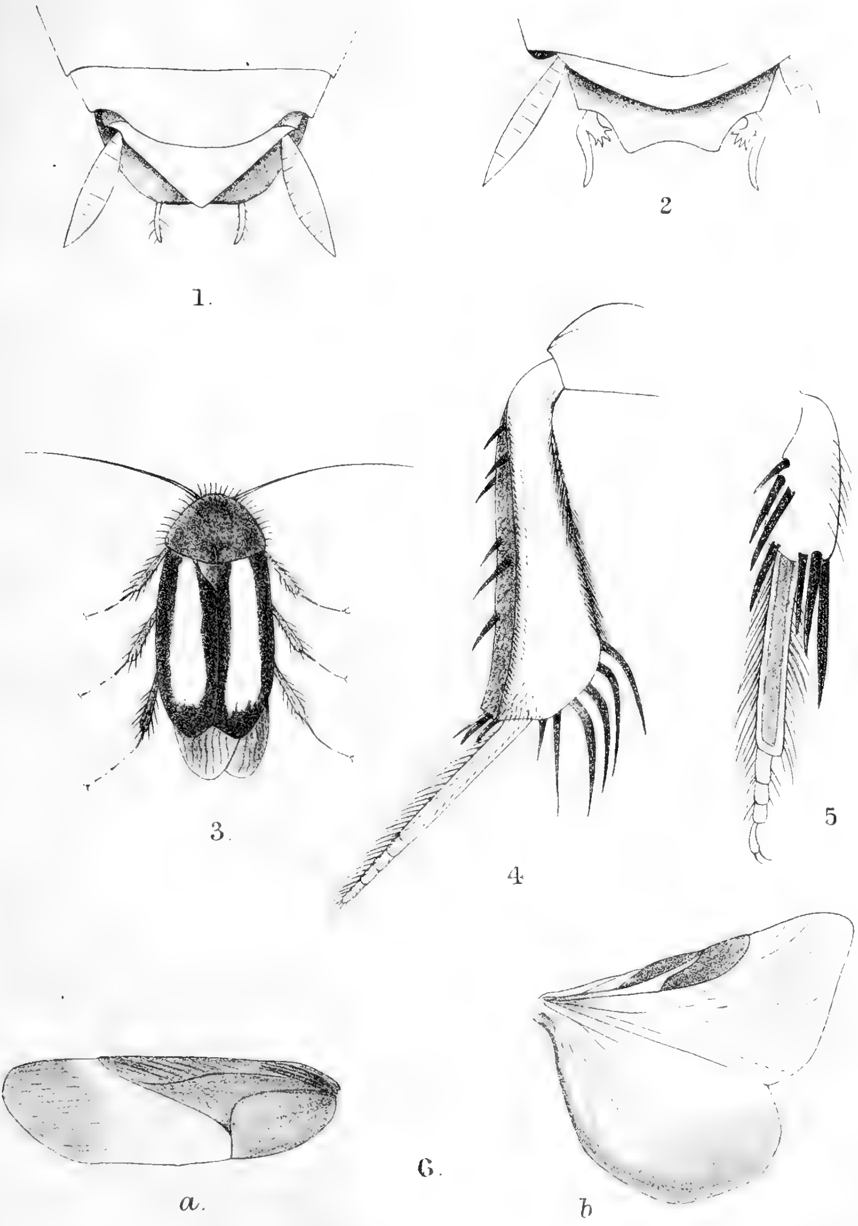
Fig. 2. Apex of abdomen of *Stylopyga togoensis*, sp. n., ♂. Dorsal aspect. Note the large genital styles.

Fig. 3. *Euthyrrapha vittata*, sp. n., ♀. × 6.

Fig. 4. Left hind tibia and tarsus of *Nymphrytria mirabilis*, gen. et sp. n., ♀.

Fig. 5. Left mid tibia and tarsus (from below) of *Polyphaga platypoda*, sp. n., ♀.

Fig. 6. *a*, Left tegmen, *b*, Right wing of *Holocompsa capsoides*, sp. n., ♂.



R. S. del.

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PRELIMINARY DIAGNOSES OF SOME NEW GENERA OF *BLATTIDÆ*.

BY R. SHELFORD, M.A., F.L.S.

The name *Phyllodromia* being occupied in the *Diptera*, it is evident that it cannot stand also for a genus of cockroaches. In 1903, Mr. A. N. Caudell proposed the name *Blattella* as a substitute for *Phyllodromia*, Serville, the type of the genus being the *Blatta germanica* of Linnæus. Most Orthopterists followed his lead, but I confess that I was not of the number. It had long been obvious that the genus *Phyllodromia* of Serville stood in urgent need of revision and sub-division, for it had become nothing but a dumping-ground for species which would not fit into the other genera of the sub-family. As I did not see my way clear to a useful revision of this heterogeneous assemblage of species, there appeared to be no particular object to be gained by substituting *Blattella* for *Phyllodromia* in the case of species which evidently were not strictly congeneric with *germanica*, L. The ill-considered transference of names in zoological nomenclature is a fruitful source of irritation, and many zoologists apparently fail to realize that the substitution of a new name for an old one is not always the only thing needed to reduce confusion to order. If they did realize it they would avoid such scandals as the alteration of the name of a British bat three times in less than that number of years.*

My refusal to follow Mr. Caudell's lead evoked some rather caustic criticism on the part of that entomologist in the pages of the Proceedings of the Entomological Society of Washington, and as the Washington Entomological Society refused to give me a hearing in the pages of their publication, I may perhaps be excused for publishing in this Journal something in the nature of an apologia.

As the result of examining the types of several critical species, I have come to the conclusion that *Phyllodromia*, Serv., can be split up into at least six genera, one of which is *Blattella*, Caud., and *Phyllodromia* may now safely be relinquished to the Dipterists.

The following are short diagnoses of *Blattella* and of the new genera:—

Blattella, Caud.

Antennæ setaceous. Tegmina and wings exceeding the apex of the abdo-

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* The nomenclature of the Mammalia is, however, in such a state of flux that no man knoweth from one day to another what the recognised scientific names of such well-known animals as, for example, the Chimpanzee and Barbary Ape, really are.

men. Tegmina with longitudinal discoidal sectors. Wings with the anterior part rather narrow, scarcely tapering to the base, ulnar vein simple or bifurcate, very rarely tri-ramose, no apical triangle. Front femora armed on the anterior margin beneath with a complete row of spines, the more distal shorter than the more proximal (Type A). Sexes similar. Ootheca coriaceous, carried by the female with the suture directed to one side.

Type of the genus: *Blatta germanica*, L.

Neoblattella, gen. n.

Resembles *Blattella*, but differs in the following points: the anterior part of the wing is broader, especially at the apex, and tapers towards the base; the ulnar vein of the wings is ramose. The apical triangle is inconspicuous or absent.

Type of the genus: *Blatta adspersicollis*, Stål.

Margattea, gen. n.

Differs from *Neoblattella* in the armature of the front femora; these are armed on the anterior margin beneath with 3 to 5 strong spines succeeded distally by a close-set row of minute piliform spines (Type B).

Type of the genus: *Blatta ceylonica*, Sauss.

Supella, gen. n.

Sexes dissimilar. Male rather narrow and elongate, with the tegmina and wings extending considerably beyond the apex of the abdomen. Tegmina with the discoidal sectors oblique. Wings with the ulnar vein ramose, no apical triangle. Front femora armed after Type A. Female shorter, broader, more convex, resembling certain species of *Ceratinoptera*; tegmina and wings not exceeding the apex of the abdomen; ulnar vein of wing ramose. Ootheca chitinous, carried with the suture directed upwards.

Type of the genus: *Blatta supellectilium*, Serv.

Eoblatta, gen. n.

Sexes similar. Form not conspicuously narrow and elongate. Tegmina and wings not exceeding the apex of the abdomen by much. Tegmina with the discoidal sectors oblique. Wings with the anterior part broad, tapering to the base, ulnar vein ramose, apical triangle inconspicuous or absent. Front femora armed after Type B.

Type of the genus: *Blatta notulata*, Stål.

Chorisoblatta, gen. n.

Tegmina with the discoidal sectors oblique. Wings with the anterior part broad and tapering to the base, ulnar vein ramose, a large, well-marked apical triangle. Femora armed after Type A or Type B, remaining femora strongly armed.

Type of the genus: *Blatta liturifera*, Stål.

This genus is erected for some of those species which have been included in the genus *Pseudectobia*, Sauss. The type of *Pseudectobia* is *luneli*, Sauss., a small species with the femora very sparsely armed as in the *Ectobiinæ*, and with a small and ill-defined apical triangle. It is a puzzling species, and the only specimen that I have seen is the very shattered type preserved in the Geneva Museum, but it is plainly not congeneric with *liturifera*, Stål, and indeed is more suitably placed in the *Ectobiinæ*. I must own to considerable alteration of opinions about the species of *Pseudectobia*, and I should like to cancel a good deal of that which I have written about the genus. In extenuation I can only plead that the author of the genus, de Saussure, was very vague himself about its limitations, and has brigaded under its heading a number of widely separated species belonging both to the *Ectobiinæ* and to the *Pseudomopinæ* [= *Phyllodromiinæ*]. In a more extended memoir I hope to clear up all the confusion definitely, having now examined all the types I am in a better position to do so than formerly.

A few words are necessary to explain the systematic position of the genera *Liosilpha*, Stål, and *Mareta*, Bol., both of which have by some authors been considered as synonymous with *Phyllodromia*, Serv. *Liosilpha pumicata*, Stål, the type of *Liosilpha*, is a very broad, short, and rather convex species, with the discoidal sectors of the tegmina oblique, the ulnar vein of the wings ramose, no apical triangle, and the front femora armed after Type A, the tegmina and wings do not exceed the apex of the abdomen, and the species has very much the appearance of an *Allacta*. In my opinion the genus can stand.

Mareta, Bol., resembles *Eoblatta*, mihi, but the marginal field of the tegmina is much broader, and the front femora are armed on the anterior margin beneath with minute piliform spines only. *Onychostylus*, Bol., is undoubtedly synonymous, the genus was based (as indeed was *Mareta*, too) on secondary sexual characters of the male sex, eminently untrustworthy characters for generic discrimination. An examination of the type, *O. unguiculatus*, Bol., shows that in all other important details of its anatomy it agrees with *Mareta*. A considerable number of species described under *Phyllodromia* I find to be true species of *Mareta*.

7, Clarendon Villas, Oxford:
June 6th, 1911.

XII. *Studies of the* Blattidae. By the late R. Shelford, M.A.

[Read June 5th, 1912.]

Plates LXXIX—LXXX.

A revision of the genus *Theganopteryx*, Br., together with remarks on some species of *Hemithyrsocera*, Sauss.

The great numbers of obscure and still undescribed species of cockroaches belonging to the subfamilies *Ectobiinae* and *Pseudomopinae* have convinced me that much more accurate and detailed diagnoses of genera must be drawn up if any order is to be introduced into the chaos at present existing. This is a task of no mean difficulty, for whilst the differences between the males of the various species are patent enough, the females resemble each other very closely, and the presence of characters which will enable the entomologist to brigade the species into genera can only be demonstrated after the most meticulous examination of all the external anatomy of the insects. But a still greater difficulty confronts the student. The characters hitherto employed to separate the subfamilies *Ectobiinae* and *Pseudomopinae* are so variable and so interchangeable that the allocation of a species or genus to this subfamily or that is as often as not dependent almost entirely on the personal opinion of the entomologist. So intimately do the subfamilies interlock that more than once I have considered the advisability of merging the two subfamilies, and I think that I would do so had I not a lingering conviction that further study of the species, both described and undescribed, will bring to light some really reliable diagnostic characters. Not one of the characters usually employed to distinguish the *Ectobiinae* from the *Pseudomopinae* is peculiar to the former subfamily. The transverse supra-anal lamina of the male, the sparse armature of the femora, the well-defined apical triangle of the wings occur sporadically in the *Pseudomopinae*. When these three important characters are shown by one species it is

easy to recognise that species as a typical Ectobiine. But what of the species that exhibit, let us say, two of the above-mentioned features, whilst the third character is typical of the *Pseudomopinae?* It is true that the *Ectobiinae* as a whole have a general facies which enables the expert to recognise them almost at a glance, but it is impossible to define this facies in cut-and-dry phrases. For example, it would be folly to remove "*Theganopteryx*" *malagassa* Sauss., from the *Ectobiinae,* or the two species of *Chrastoblatta* from the *Pseudomopinae.* Yet in the former species the apical triangle is not sharply marked off from the rest of the wing, and the two latter species have the femora most sparsely armed. Quite apart from this difficulty of expressing in words the Ectobiine facies, there is the difficulty of placing the genera which present neither an Ectobiine nor a Pseudomopine facies; these baffle even the specialist. *Mallotoblatta,* Sauss., and *Escala,* mihi are cases in point,* they present some Ectobiine characters but do not *look* like *Ectobiinae,* and to include them in the *Ectobiinae* renders a diagnosis of the whole subfamily more difficult than ever, and the same happens if they are included in the *Pseudomopinae.*

It is perhaps the irony of fate that in this, my last serious contribution to the taxonomy of the *Blattidae,* I feel compelled to recant some of the opinions expressed in my first essay on the same subject. In that paper (Trans. Ent. Soc. London, 1906) I, with all the rashness of inexperience, rushed in where such authorities as Brunner von Wattenwyl and de Saussure had feared to tread, and declared with no uncertain voice that the simple or bifurcate ulnar vein of the wing was a character of the greatest reliability whereby to separate the *Ectobiinae* from the *Pseudomopinae.* The position cannot be held. Reliance on this character involved the removal of *Hemithyrsocera* from the *Pseudomopinae* to the *Ectobiinae,* but further knowledge has shown me that its genus is akin to *Blattella,* in fact the two genera grade into each other. Moreover, when the wings of a cockroach become reduced in size or semi-aborted the first wing-veins to disappear are the branches of the ulnar vein, consequently nearly all the species of *Ceratinoptera,* a truly typical

* It is some comfort to know that de Saussure was evidently as puzzled about the correct systematic position of *Mallotoblatta* as I am.

Pseudomopine, would, following my erroneous views, fall into the *Ectobiinae.* It is perfectly true that the simple or bifurcate ulnar vein of the wings is an Ectobiine character, there being but few exceptions (*Anaplectoidea* and one or two species of *Anaplecta*), but it occurs so often amongst the *Pseudomopinae*, that taken by itself it has no great diagnostic value.

It was my intention to write a complete revision of the Ectobiine genera, but circumstances over which I have no control prevent me from accomplishing this piece of work, either now or in the future, and I must content myself with giving a definition of the *Ectobiinae*, a revision of one characteristic Ectobiine genus, *Theganopteryx*, Br., and descriptions of a few critical species of *Hemithyrsocera*, Sauss. I hope that my researches will enable other orthopterists to recognise clearly the differences which separate the two genera—a point in classification which was never very clear before, and by that means to discern the characters of the two subfamilies to which the two genera belong.

i. Diagnosis of the Sub-family Ectobiinae.

Fully winged, or tegmina and wings reduced, or aborted, or absent. Sexes similar or dissimilar. Vertex of head not covered by pronotum, which is transversely elliptic or trapezoidal. Tegmina with discoidal sectors longitudinal or oblique. Wings nearly always with simple or bifurcate ulnar vein; a triangular apical area is invariably present except in those forms in which it has developed into a large apical field, reflected when the wing is folded; the triangular apical area is typically defined very clearly and easily distinguished from the rest of the wing. Supra-anal lamina of the male generally short and transverse. Subgenital lamina of the male and the styles generally asymmetrical. Femora usually very sparsely armed. Oötheca chitinous and carried with the suture uppermost.

ii. Revision of the genus Theganopteryx, Br.

I was led to a revision of this genus by an examination of its type, *T. lucida*, Br., which was kindly lent to me with several others by Dr. Dohrn of the Stettin Museum. The type has lost its abdomen and never was provided with a locality label, for the describer hazarded the opinion that the species came from Australia. On seeing

the specimen I recognised its identity with a long series of the same species in the Genoa Museum collection, then in my hands, which came from West Africa, and I have no doubt that Brunner's type was taken, as were many other species in the Stettin Museum described by the same author, in Old Calabar. The genus being a critical one I made a very careful examination of the type and of the Genoa specimens, and in course of time arrived at the conclusion that the genus was far more limited in scope and in its geographical distribution than had been supposed by the authors who followed Brunner. *Theganopteryx* is in fact confined, so far as our present knowledge goes, to Tropical Africa. The majority of species which by other authors as well as by myself have been referred to this genus belong in reality to the almost cosmopolitan genus *Hemithyrsocera*, Sauss., but for the Malagasy species of *Theganopteryx* I have recently erected the new genus *Eutheganopteryx*. In the following revision I have thought it advisable to describe at some length every species of the genus, it is certainly convenient to have under one cover a complete conspectus of a genus.

Genus THEGANOPTERYX, Br.

Theganopteryx, Brunner v. Wattenwyl, Nouv. Syst. d. Blatt., p. 53 (1865); Saussure, Mém. Soc. Sc. Phys. Nat. Genève, xx, p. 229 (1869); Saussure and Zehntner, Biol. Centr.-Amer. Orth., i, p. 16 (1893).

Sexes similar. Antennae setaceous. Pronotum trapezoidal. Tegimna extending beyond the apex of the abdomen; costals regular, radial vein simple, discoidal sectors longitudinal, anterior ulnar usually simple, posterior ulnar multiramose. Wings fully developed; mediastinal vein 3- 5-ramose, rarely simple, costals regular, incrassated, radial vein simple, ulnar vein simple or bifurcate running close to the vena dividens, the interspace seldom crossed by transverse venules, its apex bent up and frequently failing to reach outer margin of wing impinging on the boundary of the apical triangle, medio-discal area 3–4 times broader in the middle than the medio-ulnar area. Triangular apical area well-defined, prominent, clearly marked off from rest of wing. Supra-anal lamina variable but typically trigonal. Sub-genital lamina (♂) more or less asymmetrical. Femora moderately armed beneath; front femora on the anterior margin beneath armed according to

Type B. Tarsi long, posterior metatarsi longer than the succeeding joints.

Type of the genus—*T. lucida*, Br.

Distribution of the species—West Africa, Congo region and N.E. Rhodesia.

KEY TO THE SPECIES.

1. Unicolorous, testaceous or castaneous.	
2. Eyes close together on vertex of head (almost touching in ♂)	*T. fantastica*, Shelf.
2′. Eyes not close together on vertex of head.	
3. Species barely exceeding 10 mm. in length	*T. camerunensis*, sp. n.
3′. Species much exceeding 10 mm. in length.	
4. Uniform castaneous	*T. nitida*, Borg.
4′. Uniform testaceous	*T. obscura*, Shelf. (♂).
1′. Not unicolorous.	
2. Pronotum without darker vittae.	
3. Pronotum unicolorous	*T. obscura*, Shelf. (♀).
3′. Pronotum not unicolorous but piceous, marginal with hyaline .	*T. gambiensis*, Shelf.
2′. Pronotum with 2 castaneous vittae or blotches.	
3. Pronotum with 2 castaneous blotches at base.	*T. affinis*, sp. n.
3′. Pronotum with 2 castaneous vittae.	
4. Tegmina uniform testaceous . .	*T. rhodesiae*, sp. n.
4′. Tegmina not uniform testaceous.	
5. Apex of anal field of tegmina hyaline; sub-genital lamina (♂) scarcely asymmetrical .	*T. notata*, sp. n.
5′. Anal field concolorous; sub-genital lamina (♂) very asymmetrical	*T. lucida*, Br.

Theganopteryx fantastica, Shelf. (Plate LXXIX, fig. 1.)

Theganopteryx fantastica, Shelford, Mem. Soc. españ. Hist. Nat. i, No. 27, p. 476 (1909).

♂. Pale flavo-testaceous. Head and antennae unicolorous; eyes piceous, almost touching on vertex of head. Pronotum unicolorous.

Tegmina with 19 costals, radial and anterior ulnar veins simple, posterior ulnar 5-ramose. Wings hyaline, costal margin faintly suffused with flavid, mediastinal vein simple, 18 costals the more proximal slightly incrassated, medio-discal area nearly four times broader in the middle than the medio-ulnar area, crossed by about 13 transverse venules, a prominent apical triangle, 1st axillary 4- to 5-ramose. 1st abdominal tergite produced as a flat narrow process extending nearly to the apex of the abdomen, grooved along its dorsal aspect and slightly spatulate at its extremity; 8th tergite depressed and punctate in the middle, the posterior angles triangularly produced. Supra-anal lamina quadrately produced, apex slightly bilobed, covering the bases of the cerci which are short and situated close together. Subgenital lamina produced, asymmetrical, apex concavely emarginate, two minute styles. Femora moderately armed, front pair with 3 stout spines on the anterior margin beneath, succeeded distally by piliform setae (Type B).

♀. Similar, eyes less close together on vertex of head. Wings, uniformly suffused with pale flavid. Supra-anal lamina produced, trigonal; subgenital lamina semi-orbicular, ample. Cerci longer not situated close together.

Total length (♂) 9 mm., (♀) 11 mm.; length of body (♂) 8·1 mm., (♀) 9·6 mm.; length of tegmina (♂) 7 mm., (♀) 9·5 mm.; pronotum (♂) 2·9 mm. × 3·2 mm., (♀) 3 mm. × 4·5 mm.

Hab. S.E. and N. Kamerun (*Conradt*) (Berlin Mus., types; coll. Bolivar); Biafra, Cabo S. Juan (*Escalera*) (Madrid Mus.; Oxford Mus.).

Theganopteryx camerunensis, sp. n.

Differs from *T. fantastica* by the greater distance apart of the eyes in both sexes, the smaller size of the ♀, the absence of the process of the 1st abdominal tergite in the ♂. Colour and venation as in *T. fantastica*. Supra-anal lamina (♂) subquadrate, not strongly produced, apex emarginate, (♀) triangular. Subgenital lamina (♂) symmetrical, posteriorly concavely emarginate, two minute styles. Cerci short, fusiform, very broad at base with 8 visible joints in ♂, narrower and longer in ♀.

Total length (♂) 8·5 mm., (♀) 9 mm.; length of body (♂) 7·1 mm., (♀) 7 mm.; length of tegmina (♂) 7 mm., (♀) 7 mm.; pronotum 2 mm. × 3 mm.

Hab. S.E. Kamerun (*Conradt*) (Berlin Mus., type ♂; coll. Bolivar, type ♀).

Theganopteryx affinis, sp. n.

♂. Closely allied to *T. fantastica*, but tegmina with anal field and a stripe on the discoidal field, castaneous; distance apart of eyes on vertex of head greater than the breadth of the 1st antennal joint; wings faintly suffused with castaneous, ulnar vein bifurcate, the rami joining again at their extremities. Secondary sexual apparatus of ♂ as in *T. fantastica*. Posterior angles of 8th abdominal tergite less produced; supra-anal lamina not sub-bilobate. Subgenital lamina symmetrical, apex concavely emarginate, two styles. Cerci narrower, situated less close together, their bases not hidden by the supra-anal lamina.

Total length 10·2 mm.; length of body 8·1 mm.; length of tegmina 8 mm.; pronotum 2–2·5 mm. × 2·5–3 mm.

Hab. CONGO STATE, W. of Kambove, 3,500′–4,500′ (*S. A. Neave*) (British Mus., type).

Theganopteryx nitida, Borg. (Plate LXXIX, figs. 2, 3.)

Theganopteryx nitida, Borg. Bih. Svensk. Vet.-Akad., Handl. xxviii, Afd. 4, No. 10, p. 4, pl. 1, fig. 8 (1904).

♂. Castaneous or rufo-castaneous, unicolorous. Antennae fuscous, not incrassated. Tegmina with 19–21 costals, radial and anterior ulnar veins simple, posterior ulnar 6-ramose. Wings suffused with castaneous, mediastinal vein 4-ramose, 21 costals, the proximal 16 slightly incrassated, medio-discal area in the middle about four times broader than the medio-ulnar area, crossed by 14 transverse venules, ulnar vein bifurcate, flexuose, reaching the outer margin, 1st axillary vein 7-ramose, triangular apical area large, prominent. Posterior margin of penultimate tergite sinuate; no scent-gland opening visible. Supra-anal lamina very asymmetrical, its posterior angles produced as two incurved hooks, the right overlapping the left. Subgenital lamina surpassing the supra-anal lamina, produced, asymmetrical, irregularly notched on the left side, apex with a blunt style. Cerci moderate, 9-jointed. Legs testaceous.

Total length 11·5 mm.; length of body 9 mm.; length of tegmina 9·8 mm.; pronotum 3 mm. × 3·1 mm.

Hab. KAMERUN (*Sjöstedt*, Stockholm Mus. type; *Conradt*, coll. Bolivar); BIAFRA, Cabo S. Juan (*Escalera*, Madrid Mus.).

Theganopteryx obscura, Shelf.

Theganopteryx obscura, Shelford, Rev. Zool. Afric. i, fasc. 2, p. 199 (1911).

♂. Uniform flavo-testaceous. Head castaneous, antennae fuscous; eyes piceous, their distance apart on vertex of head nearly equal to 1st antennal joint. Pronotum posteriorly produced very obtusely. Tegmina with 23 costals, radial and anterior ulnar veins simple, 7 discoidal sectors. Wings faintly suffused with ochreous, mediastinal vein simple, 15 costals, medio-discal area in middle about four times broader than medio-ulnar area, crossed by about 15 transverse venules, ulnar bifurcate, the rami joining at their apices, a prominent triangular apical area. Scent-gland openings on the 2nd and 7th abdominal tergites; supra-anal lamina trigonal, surpassed by the subgenital lamina which is produced, symmetrical, posteriorly emarginate and furnished with 2 minute styles. Cerci short, sub-acuminate, situated close together at base.

♀. Tegmina with the discoidal field and the disc of the abdomen beneath castaneous, supra-anal lamina triangular, cerci longer and more slender.

Total length (♂) 11·1 mm., (♀) 11·5 mm.; length of body (♂) 10 mm., (♀) 8·5 mm.; length of tegmina (♂) 9·1 mm., (♀) 9·1 mm.; pronotum 3 mm. × 3·5 mm.

Hab. CONGO STATE, West of Kambove, 3,500′–4,500′ (*S. A. Neave*) (British Mus.), S.E. Katanga (*S. A. Neave*) (British Mus., Oxford Mus.), Kapema-Kipaila (*Sheffield Neave*) (Musée du Congo); N.E. RHODESIA, Serenje District (*S. A. Neave*) (British Mus.), Chisinga plateau (Oxford Mus., types); PORTUGUESE E. AFRICA, Kurumadzi River (*C. F. Swynnerton*, Oxford Mus.).

Theganopteryx gambiensis, Shelf. (Plate LXXIX, fig. 4.)

Theganopteryx gambiensis, Shelford, Trans. Ent. Soc. London, 1906, p. 236.

♂. Head castaneous; antennae fuscous, ciliate. Pronotum castaneous, anteriorly and laterally margined with testaceous. Tegmina and wings exceeding the apex of the abdomen. Tegmina flavo-hyaline, outwardly margined with hyaline, 10 costals the last two ramose, radial vein simple, anterior ulnar 3-ramose, 8 discoidal sectors. Wings with anterior part faintly suffused with castaneous, mediastinal vein 4-ramose, radial vein simple, 8–9 costals, slightly incrassated, ulnar vein bifurcate, the rami reuniting at apex, not

reaching the margin of the wing, medio-discal area a little more than twice as broad as medio-ulnar area crossed by a few transverse venules, triangular apical area very large, the vena dividens crossing it in the lower half, 1st axillary 3-ramose. Abdomen above piceous in basal half, the tergites margined laterally and posteriorly with testaceous, rufous in apical half; scent-gland opening on 7th tergite; supra-anal lamina trigonal. Abdomen beneath piceous, laterally margined with testaceous; sub-genital lamina asymmetrical bordered on either side by lappets, the inflexed margins of the 9th tergite, the left lappet with apex slightly produced, the right style minute, the left stout, hirsute, more or less concealed beneath the lamina. Cerci fuscous, moderate, 9-jointed. Coxae castaneous at base, testaceous at apex; femora castaneous; tibiae flavo-testaceous tipped with castaneous.

Total length 13 mm.; length of body 10·5 mm.; length of tegmina 11 mm.; pronotum 4 mm. × 4·3 mm.

Hab. GAMBIA (Oxford Mus., type).

Theganopteryx rhodesiae, sp. n.

♂. Testaceous. Head flavo-testaceous; antennae fuscous. Pronotum with two broad castaneous vittae, lateral margins hyaline. Tegmina with 20 costals, 6 longitudinal discoidal sectors, anterior ulnar simple. Wings with marginal field infuscated, mediastinal vein 3- 4-ramose, 13 incrassated costals, medio-discal area about twice as broad as the medio-ulnar, crossed by 12 transverse venules, ulnar vein bifurcate, upper half of triangular apical area crossed by two veins, 1st axillary 3-ramose. Abdomen fuscous with pale lateral margins. Supra-anal lamina rounded, surpassed by the subgenital lamina which is produced and symmetrical; styles absent. Cerci piceous, situated close together at base. Legs testaceous.

♀. Similar, but in some examples the tegmina and wings do not extend beyond the apex of the abdomen. Supra-anal lamina trigonal, sub-genital lamina semi-orbicular ample.

Total length (♂) 9 mm., (♀) 7–9 mm.; length of body (♂) 8 mm., (♀) 8 mm.; length of tegmina (♂) 9 mm., (♀) 7–9 mm.; pronotum 2–5 mm. × 3 mm.

N.E. RHODESIA, shores of L. Bangweolo and Upper Kalungwisi valley (*S. A. Neave*) (Oxford Mus., types).

Theganopteryx notata, sp. n. (Plate LXXIX, fig. 5.)

♂. Head testaceous, antennae fuscous, setaceous, distance apart of eyes on vertex of head less than length of 1st antennal joint. Pro-

notum testaceous with 2 broad fuscous vittae. Tegmina and wings exceeding the apex of the abdomen. Tegmina castaneous, the marginal field and the apex of the anal field testaceo-hyaline, 14–16 costals, radial and anterior ulnar veins simple, 6 longitudinal discoidal sectors. Wings suffused with castaneous, mediastinal vein 3-ramose, 14 costals the first 8 incrassated, medio-distal area in middle about 3 times broader than medio-ulnar area, crossed by 12 transverse venules, ulnar vein bifurcate, the rami sometimes reuniting at their apices, triangular apical area large and conspicuous, 1st axillary 4-ramose. Abdomen castaneous above, laterally margined with testaceous, beneath testaceous, laterally margined with castaneous. Scent-gland opening on 7th abdominal tergite; supra-anal lamina bullate, apex emarginate with a small tuft of rufous hairs on either side of the notch; surpassed by the sub-genital lamina which is symmetrical, produced, with the apex emarginate, right style minute, left style stouter, curved, median in position. Cerci moderate, 8-jointed. Legs testaceous.

♀. Similar, supra-anal lamina trigonal.

Total length 9–10 mm.; length of body 9 mm.; length of tegmina 8–8·5 mm.; pronotum 3–5 mm. × 4 mm.

Hab. French Congo, Ndjole, Lambarene, Fernand Vaz (*L. Fea*) (Genoa Mus., types; Oxford Mus.).

Theganopteryx lucida, Br. (Plate LXXIX, figs. 6 and 7.)

Ectobia [*Theganopteryx*] *lucida*, Brunner von Wattenwyl, Nouv. Syst. Blatt., p. 62 (1865).

♂. Rufo-testaceous. Distance apart of eyes on vertex equal to length of 1st antennal joint. Pronotum with 2 broad fuscescent vittae, occasionally obsolescent. Tegmina and wings exceeding the apex of the abdomen. Tegmina suffused with castaneous near the base, 17–20 costals, radial and anterior ulnar veins simple, 5–6 longitudinal discoidal sectors. Wings with the veins castaneous, mediastinal vein 4-ramose, 12–14 costals, all but the last 2 or 3 incrassated, medio-discal area in middle 3 times broader than the medio-ulnar area crossed by about 15 transverse venules, ulnar vein bifurcate, the rami reuniting at their apices, triangular apical area large and prominent its upper half crossed by 2 venae spuriae, 1st axillary 5-ramose. Opening of scent-gland on 7th abdominal tergite; supra-anal lamina triangular, sub-truncate at apex; sub-genital lamina asymmetrical, notched to the left of the middle line, left style long and slender, right style absent. Femora as in the preceding species.

♀. Similar ; supra-anal lamina trigonal ; tegmina more heavily suffused with castaneous.

Oötheca chitinous, carried with the suture uppermost, sides and base multicarinate, the carinae produced posteriorly to form minute teeth.

Total lengths 10 mm. ; length of body (♂) 9 mm., (♀) 8 mm. ; length of tegmina 8·5 mm. ; pronotum 3 mm. × 3·5 mm.

Hab. ? KAMERUN (Stettin Mus., type ; coll. Bolivar ; Berlin Mus.) ; FRENCH GUINEA, Kouroussa (Paris Mus.) ; PORTUGUESE GUINEA, Bolama, Rio Cassine (*Fea*) (Genoa Mus., Oxford Mus.) ; FERNANDO PO, Basilé (*Fea*) (Genoa Mus.) ; BIAFRA, Cabo S. Juan (*Escalera*) (Madrid Mus.) ; CONGO STATE, Kasenga Kalumba (*Sheffield Neave*) (Musée du Congo).

One of the Portuguese Guinea examples was found in a Termites' nest. The Biafra specimens are much darker than those from other localities ; in the Kamerun examples the pronotal vittae tend to become obsolete.

iii. DIAGNOSIS OF HEMITHYRSOCERA, Sauss. (Subfamily *Pseudomopinae*).

Sexes similar or dissimilar.

Vertex of head not covered by the pronotum. Antennae setaceous but occasionally incrassated or plumose. Pronotum trapezoidal, posteriorly produced obtusely. Tegmina and wings in ♂ always exceeding the apex of the abdomen ; in the ♀ the tegmina and wings resemble those of the ♂, or in a few species the tegmina are reduced to quadrate lobes and the wings are rudimentary. Discoidal sectors of tegmina longitudinal. Ulnar vein of the wing simple, bifurcate, or rarely trifurcate ; apical triangle variable but usually much longer than broad and with ill-defined boundaries, not cutting off the apex of the ulnar vein from the outer margin of the wing. Medio-discal and medio-ulnar areas narrow. Subgenital lamina of the ♂ and styles usually very asymmetrical. Femora strongly armed, front femora armed after Type A. Oötheca a membranous or coriaceous capsule carried with the suture on one side.

Type of the Genus : *Thyrsocera histrio,* Burm.

Geographical distribution—The tropical and sub-tropical regions of the world.

Every variation of which the apical triangle of the wing seems capable is presented in this genus ; it may be very narrow and almost inconspicuous (e.g. *histrio,* Burm.,

fallax, Sauss., *massuae*, Sauss. and Z., *sabauda*, Giglio-Tos), and when in this form the type of wing-structure approaches that of *Blattella* very closely. The other extreme causes the wing-structure to resemble that of *Theganopteryx* (e. g. *circumcincta*, R. and F., *neavei*, sp. n.) and every gradation may be found between the two extremes if a large enough number of species is examined. As a matter of fact the apical triangle is not a character of the first importance, its form appears to be correlated with the relative length and breadth of the wing, which again depends largely on the body-length; the longer the wing the narrower and the more ill-defined the apical triangle is a general rule, with of course many exceptions, and the converse holds true also.

The species described below are either new to science or else of considerable interest as having long occupied very precarious situations in classification; the synonymy of *H. circumcincta*, R. and F., is a good example of the latter.

Finally I give a list of the species of *Hemithyrsocera*, and it will be noted that I have transferred to it some species from the old "portmanteau" genus *Phyllodromia*, Serv., and also some species which in my "Genera Insectorum" memoir (*Ectobiinae*) I placed in *Theganopteryx*. Concerning these latter species I shall doubtless be accused of chopping and changing, but in palliation of my offence can only urge that my predecessors appear to have held as vague and uncertain views of the limits of the two puzzling genera discussed in this paper as I did until recently. It was not till I had critically examined a large number of type-specimens that I was able to gain a clear picture of the two genera. That being done I now hope that the views expressed here are quite final and decisive, and that there will no longer be confusion between the two genera.

A word may be said in passing on the genus *Pseudectobia*, Sauss. Originally erected to include the species with a conspicuous apical triangle and multiramose vena ulnaris alarum as opposed to the simple ulnar vein of *Theganopteryx*, it gradually came to include a number of most diverse species and its boundaries became so elastic that they could not be defined with accuracy. Later, de Saussure, in his work on the Orthoptera of Madagascar, regarded *Pseudectobia* as a mere sub-genus of *Theganopteryx*, but to adopt this view involves the removal of the type species *P. luneli*, Sauss., from the genus! *P. luneli* is unfortunately

known from but a single specimen in a shocking state of preservation. I have made as careful an examination of the dilapidated type as is possible, and find that the apical triangle is not at all conspicuous, and its boundaries are ill-defined; the femora are sparsely armed and the discoidal sectors of the tegmina so far as can be seen are longitudinal, but this latter point is exceedingly doubtful, owing to the damage sustained by the tegmina. In my opinion none of the other species included by different authors in this genus are congeneric with *luncli,* and for the present I prefer to regard *Pseudectobia* as a monotypic genus.

iv. Descriptions of some Species of Hemithyrsocera.

Hemithyrsocera massuae, Sauss. and Zehntner. (Plate LXXIX, fig. 8, LXXX, fig. 9, compare also fig. 10.)

Blatta massuae, Saussure and Zehntner [*in*] Grandidier's Hist. Madagascar, Orth. i, p. 28 (1895).

♂. Flavo-testaceous. Head rufo-castaneous, eyes on vertex wide apart; antennae testaceous. Pronotum anteriorly and laterally margined with sub-opaque testaceous. Tegmina and wings barely exceeding the apex of the abdomen. Tegmina with 14–16 costals, radial-vein bifurcate from the middle, anterior ulnar bifurcate, 6–7 longitudinal discoidal sectors. Wings hyaline, veins flavous, mediastinal vein 2- or 3-ramose, 10 incrassated costals, radial vein bifurcate from middle, medio-discal area about 3 times broader than medio-discal, ulnar vein simple, triangular apical area moderately distinct, 1st axillary 3-ramose. Supra-anal lamina triangular, exceeded by the sub-genital lamina; opening of scent-gland on 7th abdominal tergite. Sub-genital lamina symmetrical, produced at apex to form a rounded and slightly deflected lobe, right style minute, left style large and shaped like a horseshoe. Cerci moderate, 9-jointed. Femora rather sparsely armed.

Total length 10·5 mm.; length of body 9 mm.; length of tegmina 8·5 mm.; pronotum 3mm. × 3·2 mm.

Hab. Abyssinia, Massowa (Geneva Mus., type); Erythraea, Mt. Geleb (Geneva Mus.).

Through the kindness of Dr. J. Carl of the Geneva Museum I have been permitted to examine one of de Saussure's specimens; it is evident that the learned Swiss entomologist overlooked the very remarkable genital styles of this species.

Hemithyrsocera circumcincta, Reiche and Fairm. (Plate LXXX, figs. 11–13.)

Blatta circumcincta, Reiche and Fairmaire, [*in*] Ferret and Galinier, Voy. Abyss., iii, p. 241, pl. 27, f. 3 (1847).

Blatta senegalensis, Saussure, Rev. Zool. (2), xx, p. 354 (1868).

Ectobia (*Theganopteryx*) *senegalensis*, Saussure, Mém. Soc. Sc. Phys. Nat. Genève, xx, p. 231 (1869).

Blatta fulvipes, Walker, Cat. Blatt. Brit. Mus., p. 105 (1868).

Blatta amoena, Walker, *t. c.*, p. 220 (1868).

Phyllodromia pulchella, Gerstaecker, Mitt. Ver. Neuvorpomm. u. Rugen, xiv, p. 61 (1883).

Theganopteryx senegalensis, var., Saussure, Ann. Mus. Civ. Genova, xxxv, p. 71 (1895).

Theganopteryx aethiopica, Saussure, *t. c.*, p. 72 (1895); Shelford, Gen. Insect. 55^{me} fasc., Blattidae, Ectobinae, plate, f. 1 (1907).

? *Temnopteryx abyssinica*, Saussure and Zehntner, [*in*] Grandidier, Hist. Madagasc., Orth., i, p. 51 (1895); Saussure, Abh. Senckenb. Ges., xxi, p. 576 (1899); Shelford, Gen. Insect., 73^{me} fasc. Blattidae, Phyllodromiinae, pl. 2, f. 3 (1908).

Temnopteryx saussurei, Bolivar, Ann. soc. ent. France, lxvi, p. 292 (1897).

Theganopteryx saussurei, Shelford, Gen. Insect., 55^{me} fasc. Blattidae, Ectobinae, p. 8 (1907); Shelford, [*in*] Sjöstedt's Kilimandjaro-Meru Exped., xvii, 2, Blattodea, p. 14 (1907).

♂. Head piceous; distance apart of eyes on vertex of head equal to length of 1st antennal joint; antennae fuscous to piceous. Pronotum castaneous, margined anteriorly and laterally with testaceous, the margins inwardly sinuate. Tegmina and wings extending beyond the apex of the abdomen. Tegmina rufo-testaceous to castaneous, outer margin hyaline, radial vein bifurcate at its middle or in the distal third, 10–13 costals, anterior ulnar simple or bifurcate, very rarely 3-ramose, 7–8 longitudinal discoidal sectors. Wings hyaline, costal margin faintly suffused with testaceous, mediastinal vein 4-ramose, radial vein bifurcate, 9–10 costals more or less incrassated, medio-discal area about twice as broad as the medio-ulnar and crossed by several transverse venules, ulnar vein simple, triangular apical area moderate, well-defined, 1st axillary vein 3- to 4-ramose. Abdomen above and beneath piceous to cas-

taneous, margined laterally with flavo-testaceous, 7th tergite more or less testaceous and bearing the scent-gland opening. Supra-anal lamina trigonal. Sub-genital lamina asymmetrical, margined posteriorly with flavo-testaceous, on either side of it a lappet formed by the inflexed margins of the 9th tergite, the lappets are asymmetrical, the left being produced into a dentiform process beset with spiniform setae, the right obliquely truncate; right style minute, left style stout, covered with long hairs and more or less hidden beneath the lamina. Cerci castaneous, moderate, 9-jointed. Coxae piceous tipped and outwardly marginal with testaceous, femora castaneous or testaceous in basal $\frac{2}{3}$ and castaneous in apical third, tibiae rufo-castaneous tipped with castaneous, tarsi fuscous, with basal joints rufous; femoral and tibial spines rufous. Femora moderately armed, front femora armed according to Type A.

♀. Long-winged form (*aethiopica*); tegmina and wings extending beyond the apex of the abdomen; tegmina castaneous, outwardly margined with testaceous; supra-anal lamina trigonal; apical half of the coxae, basal $\frac{2}{3}$ of the femora, the tibiae except at extreme base and apex, testaceous, remainder of legs castaneous. Medium-winged form (*circumcincta*); tegmina lanceolate, castaneous to rufous, together with the wings not extending beyond the 5th abdominal tergite; fore femora usually piceous, otherwise the legs are coloured as in the long-winged form; supra-anal lamina occasionally faintly emarginate. Short-winged form (*abyssinica*): tegmina quadrate not extending beyond the 1st abdominal tergite, castaneous or rufous; wings squamiform; the legs vary in colour from that described for the medium-winged form to testaceous with traces of castaneous markings at bases of coxae and femora.

♂. Total length 12–13·5 mm.; length of body 10 mm.; length of tegmina 10·5–11·5 mm.; pronotum 3 mm. × 4 mm.

♀. Total length 10–13 mm.; length of body 10–10·5 mm.; length of tegmina 3·4, 7, 10 mm.; pronotum 3 mm. × 4 mm.

Hab. Erythraea, Asmara (Oxford Mus.), Bogos (*Beccari*) (Genoa Mus.); Abyssinia (Ferret and Galinier) (Paris Mus., type of *circumcincta*), Massowa (Geneva Mus., type of *abyssinica*); Shoa, Let Marefia (*Beccari*) (Genoa Mus.); Galla Land, various localities (*Bottego*) (Genoa Mus., Geneva Mus.); German E. Africa, Kilimandjaro, Meru (*Sjöstedt*) (Stockholm Mus.; Oxford Mus.); "W. Africa" (British Mus., type of *amoena*); Senegal (Geneva Mus., type of *senegalensis*); Portuguese Guinea, Bolama (*Fea*) (Genoa Mus.); Sierra Leone (British Mus., type of *fulvipes*); Gold Coast (Geneva Mus., type of

aethiopica); TOGO, Bismarckburg (*Büttner*) (Berlin Mus.); BIAFRA, Cabo S. Juan (*Escalera*) (Madrid Mus.); KAMERUN, (Griefswald Mus., type of *pulchella*); CONGO, Buta (*Ribotti*) (Genoa Mus.).

This is a most variable species which I am unable to split up even into constant local varieties. The West African male specimens have the tegmina rufo-testaceous and the anterior ulnar vein of the tegmina usually bifurcate, but specimens from Shoa also have the tegmina rufo-testaceous, and the East African males in general sometimes have the anterior ulnar vein simple sometimes branched, so that these characters cannot be employed for subdividing the species. The form of the terminal segments of the abdomen in the male also varies within small limits, but the variations are quite independent of the geographical distribution and in some cases I believe that the variations are really due to distortion of the parts after death. The long-winged females (*aethiopica*) occur only on the West Coast, but they are found side by side with the medium-winged forms (*fulvipes*) which occur also in East Africa; the short-winged forms occur in Abyssinia (*abyssinica*) and also in Togo.

In Dr. Sjöstedt's Kilimandjaro collections was found a short-winged female with the oötheca protruding from the end of the abdomen; this oötheca was a thin-walled membranous sac, carried with the suture directed to one side and transparent so that the eyes of the contained embryoes could be seen through the walls. The oötheca, which thus differs very markedly from that of *T. lucida*, Br., is probably deposited but a few hours before the emergence of the young, and is thoroughly characteristic of the sub-family Pseudomopinae.

Hemithyrsocera neavei, sp. n. (Pl. LXXX, fig. 14.)

♂. Differs from *T. circumcincta* in larger size, antennae testaceous at base; tegmina rufo-castaneous sometimes darker at base, 15–18 costals, otherwise venation the same; left inflexed angle of 9th abdominal tergite not dentately produced; legs testaceous, the extreme base of the coxae and tibiae and the apex of the tibiae castaneous.

♀. Very similar to short-winged E. African form of *T. circumcincta* (*abyssinica*) but larger and pronotum not bordered posteriorly with testaceous.

Total length (♂) 15 mm.; length of body (♂) 12 mm., (♀) 13·2 mm.; length of tegmina (♂) 13 mm., (♀) 4 mm.; pronotum 4 mm. × 4·8 mm.

Hab. CONGO STATE, S.E. Katanga, 4,000′ (*S. A. Neave*) (British Mus., Oxford Mus.); N.E. RHODESIA, Serenje district, 4,500′ (*S. A. Neave*) (British Mus., types; Oxford Mus.).

This is quite distinct from the preceding species.

Hemithyrsocera vinula, Stål.

Blatta vinula, Stål, Oefv. Vet.-Akad. Förh., xiii, p. 166 (1865).

Blatta amoena, Walker, Cat. Blatt. Brit. Mus., p. 229 (1868) (part).

♂. Head and antennae piceous; distance apart of eyes equal to length of 1st antennal joint; antennae slightly incrassated. Pronotum piceous, margined all round with flavo-hyaline. Tegmina and wings exceeding the apex of the abdomen. Tegmina castaneous, the marginal area hyaline, the disc with a darker streak or the base darker than the apex, radial vein bifurcate in posterior third, the lower branch frequently multiramose, 12–15 costals, anterior ulnar vein bifurcate, 7 longitudinal discoidal sectors. Wings suffused with castaneous, mediastinal vein 5-ramose, 7–8 costals which with the mediastinal rami are incrassated, radial vein bifurcate, anterior ulnar vein simple, medio-discal area more than twice as broad as medio-ulnar and crossed by 7 or 8 transverse venules, triangular apical area moderate, divided only by the vena dividens, 1st axillary 4-ramose. Abdomen piceous, margined laterally with testaceous; supra-anal lamina trigonal; scent-gland opening on 7th tergite; sub-genital lamina rather asymmetrically produced, bordered with lappets as in the two preceding species, the left lappet produced. Cerci moderate, piceous. Legs piceous, apices and lateral margins of coxae testaceous, all the spines rufous. Front femora armed according to Type B.

♀. Similar to ♂, but sub-genital lamina semi-orbicular, ample, supra-anal lamina triangular.

Total length (♂) 11 mm., (♀) 12 mm.; length of body (♂) 9 mm., (♀) 10 mm.; length of tegmina (♂) 8·9 mm., (♀) 10·2 mm.; pronotum 2·8 mm. × 3·4 mm.

Hab. NATAL (Stockholm Mus., type; British Mus.); PORTUGUESE E. AFRICA, Beira (S. African Mus.); N.E.

RHODESIA, Loangwa R. (*S. A. Neave*) (Oxford Mus.); CONGO, Katanga and Lualaba R. (*S. A. Neave*) (British Mus.), Umangi (*Wilwerth*) (Brussels Mus., Oxford Mus.).

Hemithyrsocera nigerrima, sp. n.

♀. Closely allied to *H. vinula*, but the antennae not incrassated; tegmina uniform piceous except for a narrow marginal band which is testaceous and extends throughout the entire length of the tegmina; radial vein of wing simple; tarsi testaceous.

Total length 10·5 mm.; length of body 9·2 mm.; length of tegmina 9 mm.; pronotum 2·8 mm. × 3·5 mm.

Hab. KAMERUN, Jaunde-Stat (Berlin Mus., type).

Hemithyrsocera ridleyi, sp. n. (Pl. LXXX, fig. 15.)

♂. Flavo-testaceous. Antennae setaceous, testaceous; eyes widely separated on vertex of head. Pronotum widely trapezoidal, margins hyaline. Tegmina and wings exceeding the apex of the abdomen. Tegmina with 19 costals, radial vein bifurcate from the middle, anterior ulnar bifurcate, 7 discoidal sectors. Wings hyaline, mediastinal vein 4-ramose, 16 costals slightly incrassated, radial bifurcate from the middle, medio-discal area about $2\frac{1}{2}$ times broader than medio-ulnar, ulnar vein simple, discal area crossed by numerous transverse venules, triangular apical area moderate, distinct. Abdomen above banded with fuscous, no scent-gland visible, supra-anal lamina shortly triangular, apex sub-truncate. Sub-genital lamina extremely asymmetrical, on the extreme left a blunt curved process, on the inner side of this another blunt process tufted with stiff brown hairs, the rounded apex of the lamina fimbriate, the left style small situated to the right of the apex, the right style a large sinuose structure. In addition there appear under the supra-anal lamina a pair of bifurcate and denticulate processes which apparently are not connected with the gonapophyses. Cerci 12-jointed, of moderate lengths, apex acuminate. Femora very strongly armed (front femora missing).

Total length 13 mm.; length of body 12 mm.; length of tegmina 12 mm.; pronotum 3 mm. × 4 mm.

Hab. SINGAPORE, Botanic Gardens (*H. N. Ridley*), (Oxford Mus., type).

The complicated nature of the secondary sexual apparatus of this species is highly remarkable.

v. List of the Species of Hemithyrsocera.

Oriental Species.

H. histrio, Burm.
H. palliata, Fab. (= *nigra*, Br.).
H. soror, Br.
H. suspecta, Bol.
H. ferruginea, Br.
H. communis, Br.
H. lateralis, Walk.
H. ignobilis, Shelf.
H. vittata, Br.
H. fuliginosa, Br. (from *Phyllodromia*).
**H. curvinervis*, S. & Z. (from *Phyllodromia*).
**H. irregulariter-vittata*, Br. (from *Phyllodromia*.)
**H. marmorata*, Br. (from *Phyllodromia*).
H. ridleyi, Shelf.

Ethiopian Species.

H. circumcincta, R. & F.
H. neavei, Shelf.
H. vinula, Stål.
H. nigerrima, Shelf.
H. testacea, Shelf.
H. sabauda, Gig. Tos.
H. massuae, S. & Z.
H. brachyptera, Adel (from *Mallotoblatta*).
H. kraussi, Adel (from *Mallotoblatta*).
H. patricia, Gerst (from *Phyllodromia*).

Neotropical Species.

H. fallax, Sauss. (from *Theganopteryx*).
H. pilosella, S. & Z. (from *Theganopteryx*).

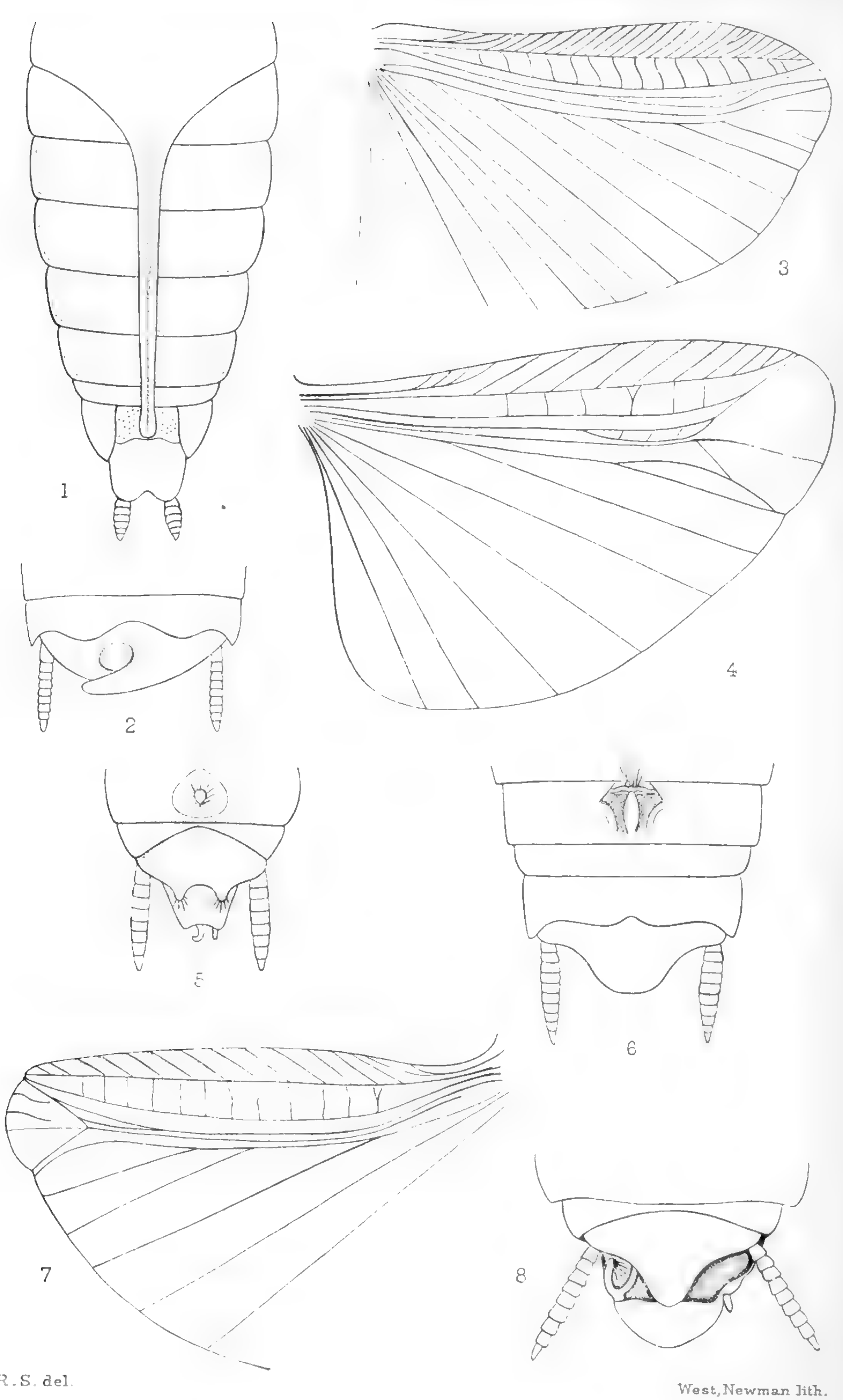
Doubtful Species.

H. tessellata, Rehn.
H. australis, Tepp.
H. apicigera, Walk.

* If eventually the genus *Hemithyrsocera* becomes overcrowded, these species can be put into a separate genus, the diagnostic character being the tri-ramose ulnar vein of the wings.

Explanation of Plates LXXIX, LXXX

[*See Explanation facing the* Plates.]



R. S. del.

West, Newman lith.

DETAILS OF BLATTIDAE.

EXPLANATION OF PLATE LXXIX.

FIG. 1. *Theganopteryx fantastica*, Shelf.—Abdomen of ♂ from above, showing the long process of the first abdominal tergite.

2. *Theganopteryx nitida*, Borg.—Apex of abdomen of ♂ from above.

3. *Theganopteryx nitida*, Borg.—Wing. Note the distorted ulnar vein. M.D. = medio-discal area. M.U. = medio-ulnar area.

4. *Theganopteryx gambiensis*, Shelf.—Wing. Note the ulnar vein impinging on the apical triangle and failing to reach the outer margin of the wing.

5. *Theganopteryx notata*, sp. n.—Apex of abdomen of ♂ from above.

6. *Theganopteryx lucida*, Br.—Apex of abdomen of ♂ from above.

7. *Theganopteryx lucida*, Br.—Wing. Note ulnar vein similar to that of *T. gambiensis*.

8. *Hemithyrsocera massuae*, Sauss. & Zehnt.—Apex of abdomen of ♂ from above. Note the horseshoe-shaped left style.

9. *Hemithyrsocera massuae*, Sauss. & Zehnt.—Apex of abdomen of ♂ in profile view.

Explanation of Plate LXXX.

Fig. 10. *Hemithyrsocera fallax*, Sauss.—Wing (drawn from all that remains of the type in the Geneva Museum) showing the small apical triangle and undistorted ulnar vein ; one extreme of the range of variation in wing-structure in this genus. The wing of *H. massuae* is practically identical with this.

11. *Hemithyrsocera circumcincta*, R. & F.—Tegmen, showing venation characteristic of this genus and of *Theganopteryx.*

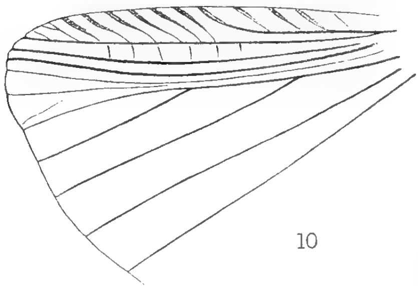
12. *Hemithyrsocera circumcincta*, R. & F.—Wing. Note the conspicuous apical triangle with well-defined boundaries and ulnar vein very slightly upturned at apex: the other extreme of variation in wing-structure shown by this genus.

13. *Hemithyrsocera circumcincta*, R. & F.—Apex of abdomen of ♂ from beneath.

14. *Hemithyrsocera neavei*, sp. n.—Apex of abdomen of ♂ from beneath.

15. *Hemithyrsocera ridleyi*, sp. n.—Apex of abdomen of ♂ from beneath.

9



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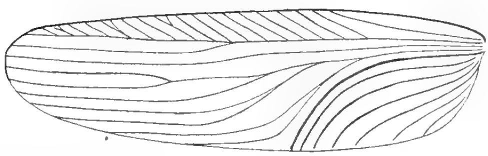

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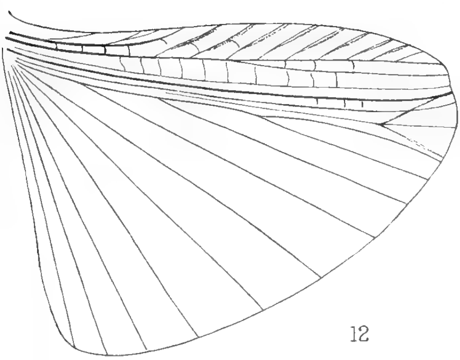

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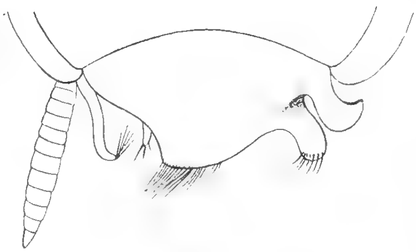

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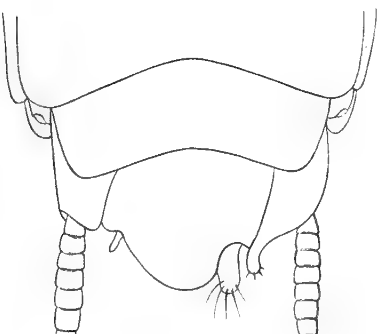

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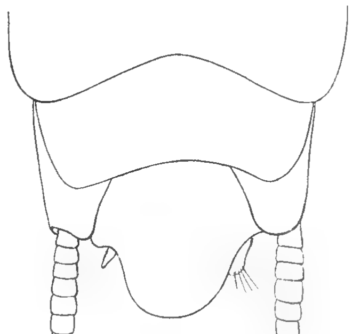

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R. S. del. West, Newman lith.

DETAILS OF BLATTIDAE.

Reprinted from "The Entomologist's Monthly Magazine," Second Series, Vol. xxi.

SOME NOTES ON THE LEPIDOPTERA OF THE "DALE COLLECTION," NOW IN THE OXFORD UNIVERSITY MUSEUM.

BY JAMES J. WALKER, M.A., R.N., F.L.S.

(*Concluded from vol.* xlv, *p.* 181).

PYRALIDINA (including *DELTOIDES*).

Madopa salicalis, W. V.—Four specimens, including one ♀ in excellent condition; labelled at side "Kent."

Sophronia emortualis, W. V.—A very fine example, apparently a ♀. Labelled "Taken by the late Charles Healey near the King's Oak, High Beech," and at side "Epping Forest." (*Cf.* Barrett, Lep. British Islands, vol. vi, p. 288).

Herminia derivalis, Hübn.—A fine series of twelve specimens, some of them on old pins; the more recent are labelled "Abbot's Wood" at side.

Pyralis lienigialis, Zell—A pair in excellent condition; the ♀ is labelled "From Rev. H. Burney coll., 1893" (C. W. D.).

Diasemia ramburialis, Dup.—One example in good order as to the wings, but lacking the antennæ and most of the legs. "Folkestone" at side; probably the specimen referred to by Barrett (*l. c.*, vol. ix, p. 258) as taken in that locality by Mr. W. Purdey in 1878.

D. literalis, Scop.—Five examples, in good condition and apparently of fairly recent date. "Devon" at side.

Antigastra catalaunalis, Dup.—A single example in very good condition "from Rev. Burney's coll." (C. W. D.), but with no further history.

Endotricha flammealis, W. V.—Two fine examples, in which the usual pinkish-fulvous ground colour is almost entirely replaced by a rich dark fuscous-brown tint. "Folkestone" at side.

Acentropus niveus, Oliv.—Four examples from "Glanvilles Wootton" stand under the label "*Garnonsii* B. E., pl. 497," and probably include the type specimen figured under the name of *A. garnonsii* by Curtis, Brit. Ent., plate 497 (April 1st, 1834), and therein referred to the *Phryganidæ* (*Trichoptera*) (*Cf.* also Stephens, Ill. Mand., vol. vi, pp. 148, 151, and "The Naturalist," vol. i, p. 14, 1837). One of these is a ♀ with rudimentary wings about 1·5 mm. in length, or proportionately of about the same size as those of *Cheimatobia brumata,* ♀; this has a printed label "foem:" and a bright red plain label. A fine ♀ with fully developed wings, among others from "G. Wootton" is labelled in a similar manner.

Margarodes unionalis, Hüb.—Three examples, indifferently set, and in fair to poor order; the best is labelled "Galley Head, L. H.," and the others, "Taken Kewton Downs, July, 1880," and "Geo. King, Torquay, 1859" (C. W. D.).

Botys repandalis, Schiff.—One fine specimen, which bears a printed label apparently cut out of a sale catalogue, "bred by Rev. H. Burney from *Verbascum,*" and "Torquay" at side. (*Cf.* Ent. Mo. Mag., vol. xxii, p. 145).

B. lupulinalis, Clk.—A fine but very badly set specimen on an old gilt pin, with label also cut out of a sale catalogue, "*taken* from Dr. A. Wallace, 1857, *Bembridge,* Isle of Wight."

Mecyna polygonalis, Hüb.—There are four of this very rare species in the collection, all set low down on rather old white and gilt pins; the best one is labelled "taken nr. Herne Bay." "Kent" at side.

Ebulea stachydalis, Zinck.—Six good specimens, three with "Freshwater" and three with "Sussex" at side.

Lemiodes pulveralis, Hüb.—Five specimens (4 ♂, 1 ♀), all except one in fine condition. "Folkestone" at side.

Scoparia cembralis, Gn.—The series of this species includes three of "v. *scotica*, White, Renfrewshire" (C. W. D.), and three of var. *zelleri*, Wocke, "Folkestone."

S. basistrigalis, Knaggs.—Three specimens from "Tilgate" and two from "Bordean" (C. W. D.), one of the latter also labelled "Bordean, July, 1844" (J. C. D.).

S. conspicualis, Hodg.—Five specimens, "Yorkshire" at side. Included in the series of this species are two rather ill-set but otherwise good specimens, labelled "*S. ulmella*, Dale," also with "Bordean" at side (C. W. D.).

S. mercurella, L.—Under this name are included some very fine and well-marked specimens of the var. *portlandica*, Dale, from Portland.

Platytes alpinellus, Hüb.—Five examples from "Hunstanton," and three from "Southsea" (C. W. D.).

Crambus culmellus, Linn.—Two almost pure white specimens are labelled "*striga, Haw.*," and there are also examples of the species from St. Kilda in the series.

C. rorellus, Linn.—Two fine specimens on rather old pins, one of which is labelled "*chrysonuchellus*, Hüb." (? J. C. D.).

C. myellus, Hübn.—Two examples, also very fine; one is labelled "Dr. B. White, Braemar, 1870" (C. W. D.).

C. verellus, Zinck.—A rather badly set example, labelled "E. R. Dale" (C. W. D.), "Christchurch" at side, and another somewhat worn "C. A. Briggs, Folkestone, '72" (C. W. D.), and "Taken by Mr. C. A. Briggs, nr. Folkestone, July 21, 1872, see Ent. Ann., 1873."

Eromene ocellea, Haw.—Two specimens, both ♂, on modern gilt pins, one badly set, the other very good; labelled "Roxburgh."

Schœnobius gigantellus, W. V.—Three examples of this species from "Whittlesea" fully merit their specific name, as a ♂ measures in expanse of wing as set, $1\frac{13}{16}$ inch (46 mm.), and two ♀'s are each 1 mm. less.

Anerastia farrella, Curt.—Three specimens, one labelled "Paget, 1841" (J. C. D.), and two "from Grigg coll., 1889" (C. W. D.), "Yarmouth" at side.

Epischnia bankesiella, Rdsn.—Three very good examples apparently bred, "Portland" at side.

Cateremna terebrella, Zk.—Two specimens, labelled "bred Norfolk, 1899;" "Merton" at side.

"*Eurhodope argyreus* (*Dubrensella*)."—Under these names are two examples of a Phycitid standing at the head of the series of *E. carnella*, L., which are

decidedly puzzling; their general shape and aspect agreeing pretty well with *carnella*, but the fore-wings being of a shining metallic silvery-grey tint longitudinally suffused with fuscous Both specimens are somewhat worn, on old bead-headed pins, and without data. I cannot find any reference to "*Eurhodope argyreus*" in our older authors, and the insects are certainly not the "*Palparia argyrea*" (*Crambus argyreus*, F.) of Haworth, Lep. Brit., p. 486.

Phycis obductella, F. v. R—A very fine specimen, labelled only "Gravesend" at side.

Rhodophæa rubrotibiella, Mann.—Six more or less worn specimens under this name, much more probably *Acrobasis verrucella*, Hübn. One is labelled "Wolmer Forest (J. C. D.)," and another "G. W., July, 1901 (C. W. D.)."

Nephopteryx similella, Zk.—A fine fresh ♂ example of this very rare and distinct-looking species bears a label "N. Forest, Gulliver 190–" (the last figure is illegible) (C. W. D.) and is undoubtedly the specimen referred to by Mr. C. G. Barrett as taken in the New Forest by Mr. C. Gulliver (Ent. Mo. Mag., vol. xxxix, p. 1, and Lep. British Islands, ix, p. 424).

N. hostilis, Steph.—Three specimens, one "Grigg coll." (C.W.D.) "Colchester" at side.

Melissoblaptes cephalonica, Sta.—Six fine specimens, "London" at side; two are labelled "Meek" and "Bower" respectively, and a very fine ♀ "Entom. xxiii, pl. iv, fig. 3."

Pterophorus rhododactylus, Fab.—Five examples, some very fine; "Chattenden" at side.

P. brachydactylus, Tr.—A very fine example of this great rarity is labelled "J. Weir's coll. 1894" (C.W.D.) and "Norfolk" at side, and is presumably the specimen taken on June 17th, 1842, at Herringfleet, Norfolk, by Mr. Farr, on which the species was introduced as British (*cf.* Barrett, Lep. British Islands, ix, p. 396.

P. paludum, Zell.—Eight specimens, "Bloxworth" at side.

Owing to my lack of special knowledge of the *Tortricina* and *Tineina*, I do not propose to deal with the very rich and extensive series of these groups in the Dale Collection, which have been recently made much more safe and more available for study, by "staging" the whole of the specimens on cards raised well above the bottom of the cabinet drawers. I may, however, draw attention to the exceedingly fine series of *Peronea cristana* and *hastiana*; the former species being represented by 224 specimens arranged under 39 varietal names, and including nearly all the forms indicated by Haworth, Curtis, Stephens, Desvignes, &c.; and the latter by 89 specimens and 17 named varieties.

"Aorangi," Lonsdale Road,
Summertown, Oxford:
July 16th, 1910.

BRITISH *ORTHOPTERA* IN THE DALE COLLECTION.

I.—Earwigs, Cockroaches, and Crickets.

BY W. J. LUCAS, B.A., F.E.S.

Reprinted from "The Entomologist's Monthly Magazine," 2nd Series, Vol. **xxii.**

Four drawers are sufficient to contain the Dale Collection of British *Orthoptera*, now located in the Hope Department of the Natural History Museum at Oxford. The Collection comprises a fair number of insects, which, though often of much interest historically, are in many cases in very poor condition. They were usually so set as to touch the paper in the drawers, making it difficult to handle them with safety. Prof. E. B. Poulton has lately, however, had them all staged, so that it is now possible to examine them without danger. All the data with the insects are referred to in these notes, even though they may seem to be unimportant. Many of the specimens, unfortunately, are entirely without data, and are therefore of very little value, if any, to students of this important order of insects. When it seemed sufficiently certain that the handwriting of the labels might be assigned to J. C. or C. W. Dale, this has been stated in brackets.

Earwigs (*Forficulodea*).

Labidura gigantea.—This earwig now known as *L. riparia,* is represented by four examples—a ♂ and a ♀ (1, 2) unlabelled, a ♂ (3) from Christchurch, and a ♀, (4) labelled "Ch. Ch., July, 1808" (J. C. D's writ.).

Labia minor.—There are twelve (5-16) specimens (7 ♂ and 5 ♀); but being unlabelled, they are without interest.

Forficula auricularia is represented by no less than thirty-six examples, the first three being named, var. *infumata.* (No. 17) is an unlabelled nymph, (18) is a female, apparently from "N. Uist" (C. W. D's writ.), and (19) is a female labelled "Fishall (?) July, 1877" (C. W. D's writ.) The next two (20, 21) are named var. *neglecta*; but they are what are usually styled *forcipata.* (20) is a male from Glanvilles Woctton (printed label), (21) pinned and having spread wings is from Eltham (?). There follow three named *forcipata.* (22) and (24) are unlabelled males, (23) is a male with two labels—the former "July (printed) 37 (J. C. D's writ.)," the second "Milton Wood" (J. C. D's writ. in red ink). (25-29) are named var. *borealis.* A female (25) is labelled "Loch (*sic*) Swilly, Donegal, J. L.," a ♀ (26) and two males (27, 28) are unlabelled. (29) on card with wings spread, bears two labels "May 18 (printed) 37" (J. C. D's writ.) and "Portland 1843" (J. C. D's writ.). The discrepancy as regards date will be noticed. The next six are named var. *arenosus.* (30) and (31) are unlabelled males, and (32), a male, has nothing more than a small blank green label. The next specimen, a female (33), is marked ♂-♀, but there is no sign of hermaphroditism; another label gives "White Sand Bay, Aug. 1864" (J. C. D's writ.). No. 34 is a male without data. No. 35, a female, has a blank green label, and a second one (printed) "White Sand Bay." The next three, all males, are styled var. *media*; 36 and 37 are without data, but the latter is a specimen of *Forficula lesnei*; 38 is labelled "und. stones Green Wall Spring 1860" (J. C. D's writ.). The rest are not assigned a varietal name. A male (39) and a female (44) are from "Dover" (J. C. D's writ.). No. 40, a male, has twisted callipers and bears a printed number "565." No. 41 bears the sign ♂-♀, and, judging by the callipers may perhaps be a hermaphrodite. The next specimen (42), a male, bears two labels—"Aug. 18 (printed) 25" (J. C. D's writ.) and on the second "1055." Nos: (43) ♀, (45) ♂ (46) ♀ (47) ♂ (48) ♀ (51) ♀ (52) ♀ are all without data. Two females (49) and (50) are labelled "Oct. 66" (J. C. D's. writ.). The last eight (45–52) are carded and have their wings spread.

Forficula lesnei.—There are twelve specimens of this interesting species under their true name, while a thirteenth (No. 37 above) appears under *F. auricularia.* The first (53), a male, has a blank red label, and a second bearing "Sep. 28, 1837." Three males (54, 56, 60) and a female (64) are without data. No. 55 is labelled "Gl. Wootton, Nov. 14/60" (J. C. D's writ.) and has a printed label also "Nov. 14, 1860" (the 14 and the 0 being filled in in J. C. D's writ.). Three males (57, 59, 62) and a female (61) are from "Weymouth, Sept. 23, 1889" (C. W. D's writ.). Two females (58 and 63) are labelled "I. of W." (J. C. D's writ.).

Apterygida albipennis is represented by three specimens—a male (65) "Charing, Sept. 17, 1904" (C. W. D's writ.), a female (66) unlabelled, and a female (67) "Charing, Kent, Sept. 17, 1904" (C. W. D's writ.).

Apterygida arachidis.—There are three examples all bearing labels in C. W. D's handwriting. They are—a male (68) "Queenborough, J. J. Walker,"

a female (69) "Queenborough, in bone sacks, Apr. 4, 1897," a female (70) "Queenborough, J. J. Walker, Apr. 4, 1897, bone sacks."

Anisolabia annulipes again is represented by three examples. All are females, labelled—(71) "Col: bakehouse. Tavistock" (C. W. D's writ.), (72) "Tavistock, H. Swale. Apr. 1894," (73), "Tavistock, Ap. 1894."

Anisolabia maritima.—There are six examples—three males (76, 78, 79) and three females (74, 75, 77). None are labelled except (77) "Northumberland" (printed). No. 78 has small callipers.

Cockroaches (*Blattodea*).

Blatta lapponica is represented by eleven examples, two only (83 and 85) carded specimens, being labelled—"Lyndhurst" (J. C. D's writ.); (88) is a carded specimen, with wings spread; (86 and 87) also have their wings spread; (89 and 90) are nymphs.

Blatta nigripes.—Seven specimens. Two (94, 95) are nymphs; (92) is labelled "Lizerd (*sic*) Oct. 18, 1873" (C. W. D's writ.); (97) "Bournemouth," 1845 (J. C. D's writ.); the rest bear no data. [This insect is in reality only a form of the next.—W. J. L.].

Blatta ericetorum.—There are eleven examples, three (98, 101, 103) being labelled "Land's End, 1864" (J. C. D's writ.) while (98) bears also a printed label to the same effect. (105) bears the letters "B. M." (perhaps in J. C. D's writing). The rest (99, 100, 102, 104, 106-108) are unlabelled. (108) is a nymph."

Blatta livida is represented by ten specimens. (109) has "1036" printed on much faded reddish paper (111) is labelled "Portland, July 30th, 1875" (C. W. D's writ.). (112) has two labels, "Bournemouth" (printed) and "Bournemouth, 1845," (J. C. D's writ.). (114) bears the date "Oct. 66" (J. C. D's writ.). 117 has the labels "Glanvilles Wootton" (printed) and "Nov/m/67" (J. C. D's writ.). 118 is labelled "B-mouth 46." The rest (110, 113, 115, 116) are without data. (114-118) are "nymphs."

Blatta germanica.—There are eleven examples (119-129), all without any data whatever. The first four only are mature, the rest being "nymphs." (126, 127) are on one card, as are also (128, 129).

Periplaneta orientalis.—Of the six examples (130–135) one only (130) has a label—"Sherborne 1887."

Periplaneta americana.—There are two specimens only—(136) labelled "R. Newstead Chester 1895" (C. W. D's writ.), and (137) bearing the number $\frac{445}{3}$.

Periplaneta australasiæ.—Again, there are two specimens (138, 139) the second being a "nymph." Both bear an inscription, the first part of which is illegible, followed by "Sherborne 1839."

Crickets (*Gryllodea*).

Acheta domestica.—There are seven examples, all unlabelled (140–146). (140, 142, 144) are males, while (141, 143, 145, 146) are females.

Gryllotalpa vulgaris.—With the exception of (151) which bears the written No. "63," all six specimens (147–152) are without data.

Acheta campestris.—This interesting species is represented by 8 examples (153–157) being males, (158–160) females. (153, 154) bear a label which appears to be "Christchurch" followed by the date "1885" (C. W. D's writ.). (155) is labelled "Christchurch July 1885" (C. W. D's writ.); by its side is also a printed label "Christchurch," which may however refer to the first four (153–156). (156) bears the printed date "May (8). 186 (8)," the two 8's in brackets being filled in in writing. (157–160) are without data.

Nemobia sylvestris is represented by nine examples (161–169). (163) is labelled "New Forest" and (166) "Brockenhurst 1874," the 4 being filled in. The rest are unlabelled. Below (168) occurs the locality "New Forest," which perhaps is intended to refer to all nine insects.

(To be continued).

28, Knight's Park,
Kingston-on-Thames:
May, 1911.

THIRD SUPPLEMENT

TO THE

PRELIMINARY LIST

OF

COLEOPTERA

IN THE

REPORT FOR 1906,

BY

JAMES J. WALKER,

Hon. M.A., R.N., F.L.S.,

Secretary of the Entomological Society of London.

THIRD SUPPLEMENT

TO THE

PRELIMINARY LIST OF THE COLEOPTERA OF THE OXFORD DISTRICT,

Published in the Report of the Ashmolean Natural History Society of Oxfordshire for 1906.

By JAMES J. WALKER, Hon. M.A., R.N., F.L.S.

THE net result of two more years (1910-11) of continuous work at the Coleopterous Fauna of the Oxford District is the addition of the very satisfactory number of 127 species, many of them very rare and local, and one well-marked new variety to the Lists already published in our Reports for 1906, 1907, and 1909. The total number of species recorded up to the present date (allowing for a few deletions from and corrections to the Preliminary List noted below) is about 1,860, or 54·3 per cent. of the species now known to have occurred in the British Islands.* Thus our District may fairly be regarded as exceedingly rich in this Order of Insects, especially when its inland situation and restricted area are taken into consideration. While definite records of the great majority of the more common and widely-spread British beetles have been obtained, there still remain a good many species, of more or less local distribution, that may reasonably be expected to turn up if the search for additions to our List is continued, and I do not altogether despair of the total number of our Oxford Coleoptera attaining to the round figure of 2,000. As before, I am indebted to Mr. W. Holland, Mr. A. H. Hamm, Mr. H. St. J. Donisthorpe, and especially to Mr. J. Collins, for the records of a very large proportion of the species here enumerated.

* The number of species in Beare and Donisthorpe's "Catalogue of British Coleoptera" (March, 1904), omitting "introduced" and "doubtful" species, is 3,274, and to these about 150 have since been added, making the total up to the present date 3,420 in round numbers.

The following corrections to the "Preliminary" and "Supplementary" Lists may be conveniently made here.

Harpalus picipennis, Dufts. Although named as this species by Capt. St. Claire Deville, the insect in question differs from it in many respects, and Mr. W. Holland and I can only regard it as a very small and abnormal ♀ example of *H. rufimanus*, Marsh. The specimen is now in the Oxford University Museum.

Haliplus confinis, Steph. This should be *H. obliquus*, Fab.

Laccobius minutus, L. Recorded in error for *L. alutaceus*, Thoms.

Helophorus mulsanti, Rye. A rather brightly-coloured form of *H. æneipennis*, Thoms., found in standing water at Tubney, has been confused with this littoral species.

Anisotoma parvula, Sahlb. The Oxford specimens hitherto regarded as this species must be referred to *A. flavicornis*, Bris. (Cf. Joy, Ent. Mo. Mag., 1908, p. 174).

Euplectus signatus, Reich. This should be *E. sanguineus*, Denny.

Scymnus ater, Kug. Recorded in error.

Cerylon ferrugineum, Steph. The insect, on the strength of which this species was inserted in the "Preliminary List," is a ferruginous form of *C. histeroides*, Fr.

Atomaria basalis, Er. Only a brightly-marked specimen of *A. analis*, Er.

Scolytus rugulosus, Ratz. Recorded in error for *S. intricatus*, Ratz.

ORDER COLEOPTERA.

Family Carabidæ.

***Pterostichus gracilis, Dej.** In damp tufts of grass, in winter and early spring, sparingly; first taken near Islip, 8th January, 1910; also at Prattle Wood and Beckley.

***Bembidium monticola, Sturm.** Gosford Bridges, near Kidlington, rare, on banks of stream, August, 1910 and 1911 (*J. C.*).

Family Haliplidæ.

***Haliplus immaculatus, Gerh.** Occurs sparingly in company with *H. fluviatilis*, Aubé, from which it has recently been separated (Ent. Mo. Mag., 1907, p. 4).

***Cnemidotus impressus, Fab.** Gosford Bridges, singly, in running water, one example, August, 1911 (*J. C.*).

Family Hydrophilidæ.

****Hydrobius fuscipes, L. var. æneus, Sol.** One example of this rare and beautiful variety taken in flood-refuse, Sparsey Bridge, R. Cherwell, 5th December, 1910.

Laccobius alutaceus, Thoms. Occasionally in running water, Gosford Bridges, &c. (*J. C.*).

****Ochthebius æneus, Steph.** Sparsey Bridge, in flood-refuse, one example, 5th December, 1910.

***O. rufimarginatus, Steph.** In flood-refuse, banks of Cherwell, also in small stream, Cutteslowe Farm, Oxon; rare.

***Hydræna testacea, Curt.** In running water, Wolvercote Paper Mill, rare, 22nd July, 1911.

***H. atricapilla, Wat.**
***H. pulchella, Germ.** } These two species were found not rarely, adhering to stonework of weir, Gosford Bridges, June to August, 1911.

FAMILY **Staphylinidæ.**

****Homæusa acuminata, Märk.** One specimen taken in débris of hedge-bottom at Enslow Bridge, May, 1910 (*J. R. le B. Tomlin*); one by sweeping at Cothill, 25th May, 1911. This species is associated with the black ant *Lasius fuliginosus*, Latr.

***Oxypoda exigua, Er.** In moss on banks of Cherwell near Water Eaton, scarce, March, 1911.

***Homalota silvicola, Füss.** By sweeping at Wytham Park, one example, 13th May, 1911.

****H. elegantula, Bris.** A single specimen of this rare and distinct species taken by sweeping on the railway-bank near Yarnton, 20th May, 1910.

***H. coriaria, Kraatz.** In wood-pigeon's nest near Wytham, several, 27th August, 1910 (*J. C.*).

***H. villosula, Kraatz.** In haystack-refuse, Water Eaton, Wytham, &c., April, 1910 (*J. C.*).

***H. cinnamoptera, Thoms.** In flood-refuse near Water Eaton, December, 1910 (*J. C.*).

***H. pygmæa, Grav.** In haystack-refuse, Water Eaton, &c., April, 1910 (*J. C.*).

***Tachyusa scitula, Er.** Bayworth, Berks, in a damp tuft of grass, 13th April, 1910 (*H. St. J. Donisthorpe*).

Gyrophæna minima, Er. Cothill, in fungus, 18th August, 1910 (*J. C.*).

***G. lævipennis, Kraatz.** In an elm stump near Tubney, 22nd July, 1910 (*J. C.*).

***Oligota granaria, Er.** In mill-refuse, Cothill, common, first taken 22nd March, 1910; also in Bayswater Mill near Headington, 1st April, 1910.

***O. apicata, Er.** In dry black fungoid growth on dead beech near Wood Eaton, not rare, 15th May, 1911.

****Hypocyptus apicalis, Bris.** In mill-refuse, Cothill, rare, May, 1911.

***Mycetoporus lucidus, Er.** Among dead beech leaves near Wood Eaton, one, 26th February, 1910.

****M. forticornis, Fauv.** In sand-pit at Tubney, 3rd July, 1904 (*Donisthorpe*). Regarded as distinct from *M. clavicornis*, Steph., by Dr. Sharp and other Coleopterists.

***Heterothops prævia, Er.** About cow-house, Water Eaton, 20th March, 1910 (*J. C.*); not uncommon in mill-refuse at Cothill, spring, 1911.

Quedius fulgidus, Fab. In sand-pit at Cumnor, among droppings of sand-martins, one, July, 1911 (*J. C.*).

***Q. scintillans, Grav.** Widely distributed throughout the district in haystacks and vegetable-refuse; first taken at Water Eaton, 20th March, 1910 (*J. C.*).

Philonthus umbratilis, Grav. In manure-heap near Water Eaton, common, March, 1910 (*J. C.*); also near Summertown, &c.

****P. ebeninus Grav., var. corruscus, Grav.** One specimen of this rare and handsome species taken in a dead hedgehog at Wytham Park, 6th August, 1910 (*J. C.*). The *P. ebeninus*, Grav., of the "Preliminary List," is now referred to *P. concinnus*, Grav. (*cf.* Joy, Ent. Mo. Mag., 1908, p. 51).

***Gabrius stipes, Sharp**
G. pennatus, Sharp
***G. velox, Sharp**
***G. bishopi, Sharp**

These species are separated from *Gabrius (Philonthus) trossulus* Nord., and *G. nigritulus*, Grav., by Dr. D. Sharp (Ent. Mo. Mag., 1910, pp. 129—131). *G. stipes* occurs in fresh dung near Water Eaton (*J. C.*); *G. pennatus* is often abundant in flood-refuse; of *G. velox* I have a single example from the district, and *G. bishopi* is found in moss at Yarnton (6th June, 1908, *J. C.*), not rarely, and in flood-refuse at "Duke's Cut" on the Canal, December, 1911.

*(**G. trossulus, Nord.** Occurs rarely in wet moss at Yarnton, also at Weston-on-the-Green.)

(**G. nigritulus, Grav.**, is the commonest species of the genus in the district.)

Lathrobium longipenne, Fairm. A single example of this exceedingly rare species was found at roots of *Echium vulgare* in a sandy field near Tubney, 29th July, 1909.

Medon apicalis, Kraatz. By evening sweeping at Water Eaton, one example, 9th May, 1911.

Sunius angustatus, Payk. This common species, which abounds everywhere in haystacks and vegetable refuse, was accidentally omitted from the "Preliminary List."

Evæstethus scaber, Grav. Taken in tufts at Bayworth, 13th April, 1910 (*Donisthorpe*): also at Cowley (*A. H. H.*)

Stenus biguttatus, L. One in a tuft on bank of pond, Cothill, 23rd January, 1911.

*S. ater, Mann.** By sweeping near Cothill, one example, 22nd May, 1909.

S. nitens, Steph. In flood-refuse, Sparsey Bridge, rare, December, 1910; also at Weston-on-the-Green.

*S. argus, Grav.** In flood-refuse, Wolvercote Paper Mill, sparingly, January, 1911 (*J. H. Keys*).

*S. ærosus, Er.** By sweeping at Wood Eaton, sparingly, May, 1911.

*Trogophlœus fuliginosus. Grav.** In manure-heaps and by sweeping; Wolvercote, rare.

*Thinobius linearis, Kraatz.** Boundary Stream, Cowley Marsh, one specimen, the prey of the Dipteron *Hilara maura*, Fab., 27th May, 1911 (*A. H. H.*).

Lesteva fontinalis, Kies. On banks of small stream near Wytham, rare, 20th April, 1908 (*J. C.*).

Homalium pusillum, Grav. Under fir bark at Besselsleigh, common, November, 1911 (*J. C.*).

*Proteinus macropterus, Gyll.** Water Eaton, March, 1911 (*J. C.*); also by sweeping at Wytham Park.

Family Clambidæ.

Clambus pubescens, Redt. Among dry grass at hedge-bottom, Enslow Bridge, March, 1910 (*J. C.*).

C. armadillo, De Geer. In sand-pit at Cumnor, frequent, July, 1910 (*J. C.*)

Family Silphidæ.

*Agathidium seminulum, L.** Cothill, under bark of rotten stump, rare July, 1910 (*J. C.*).

*Necrophorus interruptus, Steph.** In carrion near Enslow Bridge, one specimen, 31st August, 1907 (*A. H. H.*).

*Choleva coracina, Kelln.** By sweeping at Hen Wood, one example, 16th May, 1911.

*C. fuliginosa, Er.** Taken in mouse-nests, &c., at Wytham, Wood Eaton, Yarnton, &c., by Mr. J. Collins, and by myself at Wytham Park by sweeping.

Family Pselaphidæ.

*Bryaxis impressa, Panz, var. unicolor, Collins** (Ent. Mo. Mag., 1911, p. 276). This well-marked variety occurs at Yarnton sparingly with the ordinary form; first taken August, 1908 (*J. C.*).

**Trichonyx markeli, Aubé. In sand-pit at Cumnor, rare, June and July, 1910; also taken there singly by Mr. Donisthorpe and myself.

**Euplectus brunneus, Aubé. A large and fine *Euplectus*, taken by Mr. J. Collins under bark of an elm stump at Wytham with the ant *Myrmica rubra*, L., 27th July, 1910, is referred to this very rare species by Mr. G. C. Champion.

*E. punctatus, Muls. One example in very rotten ash, Wytham Park, 24th April, 1911.

*E. karsteni, Reich. In grass-tufts, Wolvercote Paper Mill, not rare; first taken 2nd April, 1910.

*E. piceus, Mots. Wytham Park, in small oak branches with the ant *Leptothorax acervorum*, Fab., 9th October, 1910 (*J. C.*); also not rarely in rotten elm, Tubney, spring, 1911.

*E. ambiguus, Reich. In flood-refuse near Yarnton, rare, 30th April, 1910, and at "Duke's Cut," sparingly, 27th December, 1911.

FAMILY Phalacridæ.

*Stilbus oblongus, Er. In flood-refuse near Yarnton; a few specimens, 10th January, 1911.

FAMILY Coccinellidæ.

*Scymnus minimus, Rossi. By sweeping near Enslow Bridge; one specimen, 1st September, 1911.

FAMILY Endomychidæ.

**Symbiotes latus, Redt. Several specimens of this interesting species have been taken in hard fungus inside a rotten elm stump at Wood Eaton, the first being found 30th January, 1911.

FAMILY Colydiidæ.

*Aglenus brunneus, Gyll. Taken in large numbers in a haystack near Water Eaton by Messrs. Holland and Collins, and subsequently by myself, March, 1910. Also sparingly at Godstow, and in mill-refuse at Cothill.

FAMILY Histeridæ.

**Plegaderus dissectus, Er. In wet rotten wood inside an elm stump, Wood Eaton, rare; first taken 13th April, 1911.

**Abræus granulum, Er. With the preceding species, also rare; first taken 5th May, 1911.

FAMILY Lathridiidæ.

*Holoparamecus caularum, Aubé. In haystack-refuse at Water Eaton, plentiful, 14th March, 1911.

*Anommatus duodecim-striatus, Müll. Taken singly in decayed seed potatoes, Wolvercote Paper Mill, 1st and 18th August, 1911.

*Enicmus histrio, Joy. Described from specimens taken by Mr. J. Collins, and recognized by him as distinct from *E. transversus*, Ol. (Ent. Mo. Mag., 1910, p. 250). Apparently not rare and widely distributed throughout the District.

*Corticaria denticulata, Gyll. In hedge-bottoms near Enslow Bridge, April, 1910 (*J. C.*); also frequent at Wolvercote Paper Mill.

*C. serrata, Payk. By sweeping at Wytham Park, rare, 15th July, 1908, and 24th July, 1911.

***C. fulva, Com.** In cow-house near Water Eaton, not rare, 24th March, 1910; also in Cothill Mill.
***Melanophthalma tranversalis, Woll.** Taken singly by Mr. J. Collins.

FAMILY **Cucujidæ**.

***Læmophlœus duplicatus, Waltl.** Under elm bark near Water Eaton, rare, May, 1907.
***L. pusillus, Schön.** In mill-refuse at Cothill, rare, March 5th, 1910.

FAMILY **Cryptophagidæ.**

Cryptophagus punctipennis, Bris. In haystacks and vegetable refuse, occasional; Water Eaton, Cothill, &c.; Enslow Bridge (*J. C.*).
C. saginatus, Sturm. In mill-refuse; Bayswater Mill, Headington, and Cothill, common.
****C. fowleri, Joy.** In rotten wood, rare; Water Eaton, November, 1909; Wytham, &c. (*J. C.*).
***Atomaria munda, Er.** In haystack near Water Eaton, common, March, 1910 (*J. C. and W. H.*); I have also found it in mill-refuse at Cothill.
****A. atra, Herbst.** Two examples at Cothill, 20th May, 1910 (*J. C.*).
***A. versicolor, Er.** Occurs sparingly in tufts, haystack-refuse, &c., at King's Weir, Wolvercote, Water Eaton, Enslow Bridge, Wytham, &c. First observed by Mr. J. Collins, March, 1910.

FAMILY **Scaphidiidæ.**

Scaphisoma boleti, Panz. In rotten wood near Enslow Bridge, common, 30th December, 1910; Wytham Park, not rare (*J. C.*).

EAMILY **Mycetophagidæ.**

***Mycetophagus quadriguttatus, Mull.** In mill-refuse at Cothill, common; first taken 23rd May, 1911.

FAMILY **Byrrhidæ.**

***Limnichus pygmæus, Sturm.** Boundary stream, Cowley Marsh; one specimen, the prey of the Dipteron *Hilara maura*, F., 27th May, 1911 (*A. H. H.*).

FAMILY **Parnidæ.**

***Elmis volkmari, Panz.** On large stones in brook near Bayswater Mill, rare, 22nd January, 1910.
***E. parallelopipedus, Mull.** On stonework of weir, Gosford Bridges; one example, 18th July, 1911.
***E. nitens, Mull.** With the preceding species, scarce; first taken 8th July, 1911.

FAMILY **Scarabæidæ.**

Onthophagus nuchicornis, L. Recorded by the late Mr. J. W. Shipp (Ent. Mo. Mag. 1893, p. 192) as having been found commonly under a dead rabbit in Bagley Wood.
***Aphodius constans, Dufts.** First taken in tufts near Marston Ferry, February, 1908; it is one of the commonest of the spring *Aphodii* in the district, occurring freely in dung on pasture-land at Summertown, Cumnor, Enslow Bridge, &c.
***Plagiogonus arenarius, Ol.** In rabbit-burrows at Tubney, sparingly; first taken 21st May, 1910.

FAMILY Telephoridæ.

***Malthinus frontalis, Marsh.** Tubney, by beating, 25th June, 1909 (*J. R. le B. Tomlin*); 22nd June, 1911 (2) (*J. C.*).

Malthodes flavoguttatus, Kies. Enslow Bridge, 17th June, 1910, and Tubney, 2nd July, 1911 (*J. C.*).

***Anthocomus rufus, Herbst.** This conspicuous species was taken in some numbers at Cothill, August, 1911 (*J. C.*).

FAMILY Ptinidæ.

****Ptinus subpilosus, Mull.** At nest of *Lasius fuliginosus* near Tubney; one example, 24th September, 1910.

P. brunneus, Dufts. In mill at Cothill, occasional; also on shop-front at Abingdon.

Niptus crenatus, Fab. In cow-house at Water Eaton, common, 24th March, 1910; also plentiful in rubbish in Cothill Mill.

FAMILY Cissidæ.

***Cis micans, Herbst.** In fungus-grown beech-wood, Wytham Park, scarce, 13th May, 1911.

C. nitidus, Herbst. In hard fungus on old stumps; Wytham Park, Wood Eaton, &c., common.

FAMILY Cerambycidæ.

****Grammoptera analis, Panz.** One example of this fine species, whose head-quarters in Britain is the New Forest, Hants, taken on the wall of the Indian Institute, Oxford, 2nd June, 1910 (*A. H. H.*)

FAMILY Chrysomelidæ.

***Chrysomela orichalcia, Mull.** Cothill, one specimen by sweeping, 23rd May, 1911; Shotover, singly, June, 1911 (*A.H.H.*).

Longitarsus pulex, Schr. By sweeping *Thymus serpyllum* in autumn, Wytham Park, common; first taken September, 1910.

***L. castaneus, Dufts.** First taken at Yarnton, 16th June, 1909 (*J. C.*); not uncommon, by sweeping in damp places there, also at Cothill, Enslow Bridge, &c.

***L. atriceps, Kuts.** First taken in a tuft at Wood Eaton, 13th February, 1911: found there subsequently not rarely by sweeping, also at Enslow Bridge, Cothill, &c.

***L. waterhousei, Kuts.** By sweeping near Beckley, rare, August, 1904 (*W. H.*).

Phyllotreta consobrina, Curt. By sweeping at Cothill, rare, June, 1909.

***Aphthona nigriceps, Redt.** On *Geranium pratense* at Enslow Bridge, sparingly, 26th August, 1911 (*J. C.*), also by myself.

***A. virescens, Foudr.** By sweeping in damp places at Yarnton, rare, July, 1910; also near Kirtlington.

***Psylliodes dulcamaræ, Koch.** On *Solanum Dulcamara* at Enslow Bridge, rare, June, 1910 (*J. C.*).

FAMILY Tenebrionidæ.

Palorus subdepressus, Woll. In mill-refuse at Cothill, rare, 22nd March, 1910.

FAMILY **Pythidæ.**

****Salpingus mutilatus, Beck.** One specimen of this rare species taken by sweeping under beech trees at Wytham Park, 14th October, 1911.

FAMILY **Curculionidæ.**

***Rhynchites cœruleus, De Geer.** Beaten from *Prunus*, Cothill, 3rd September, 1911, and under bark near Wood Eaton, 26th November, 1911 (*J. C.*); I also have it from Tubney.

***R. harwoodi, Joy.** (Ent. Mo. Mag. 1911, p. 270.) Most of the specimens recorded from the district as *R. uncinatus*, Thoms., are to be referred to this newly-described species. It occurs on sallows at Cothill (*J. C.*).

***Trachyphlœus aristatus, Gyll.** By sweeping at Tubney; one specimen, 1st September, 1910.

***Barypithes pellucidus, Boh.** By sweeping short grass under pines; Hen Wood, locally abundant, 1st June, 1911.

***Atactogenes exaratus, Marsh.** Shotover, rarely (*W. H.*).

Curculio abietis, L. This conspicuous pine-feeding weevil has been taken in the grounds of the Oxford University Museum by Mr. W. Holland.

***Gymnetron melanarius, Germ.** By sweeping in a sandy field at Tubney; one specimen, 4th June, 1910.

Acalles turbatus, Boh. In hedge-bottoms near Enslow Bridge, April, 1910 (*J. C.*).

***Ceuthorrhynchus nasturtii, Germ.** On water-cress (*Nasturtium officinale*), Cothill, very local, but not uncommon; first taken 5th September, 1910.

***C. constrictus, Marsh.** On *Erysimum Alliaria*: Wood Eaton, sparingly, May, 1911.

***C. punctiger, Gyll.** On dandelion (*Taraxacum officinale*) in early summer, Cothill and Tubney, scarce; also in moss at Cothill, 5th March, 1910.

***C. trimaculatus, Fab.** Taken singly on thistles, Tubney, 1st July, 1896 (*W. H.*).

****Ceuthorrhynchidius mixtus, Muls.** One specimen of this exceedingly rare species taken by sweeping in a grassy lane near Tubney, 16th May, and a second example at Hen Wood, 24th May, 1910.

***Phytobius quadrinodosus, Gyll.** By sweeping at Cothill; one example, 16th May, 1910.

FAMILY **Scolytidæ.**

Trypodendron domesticum, L. By sweeping near Bayworth; one example, 12th April, 1911.

31st December, 1911.

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Reprinted from "The Entomologist's Monthly Magazine," 2nd Series, Vol. xxi.

NOTES ON *CETONIA AURATA*, L., AND *C. FLORICOLA*, HERBST.

BY A. H. HAMM.

C. AURATA, L.

During a brief visit to the New Forest in August, 1908, my son and I came across some fairly large Lamellicorn larvæ. They were feeding upon the fragments of damp dead wood, at the foot of what had once been a very fine beech, now, alas! reduced to a mere stump, situated at the far end of Queen's Bower, near Brockenhurst. A few of the largest were placed in a tin box with a sufficient supply of the dead wood to enable them to arrive at maturity. Upon reaching home several of the smaller individuals were put into spirit, but five examples of the same size and apparent age were kept alive for future study. The larvæ continued feeding until quite late into the autumn. They then buried themselves in the accumulation of frass and hibernated until the following spring. Towards the end of March they again commenced feeding and continued to do so without intermission until mid-June, when four of them built from their excreta, &c., oval cocoons about the size of a good-sized hazel-nut. On August 19th the first emerged, another on the 23rd, and the remaining two on the 25th. By this last date four out of the five larvæ had produced perfect specimens of *Cetonia aurata*. The remaining larva continued feeding until some time in October, and finally hibernated as before. The four imagines, after emergence, were left in the tin box with the remaining larva. These at the beginning of September buried themselves at the bottom of the box and remained perfectly motionless, with all their limbs tightly adpressed to the body, until the beginning of April.

× 1½. C. AURATA. C. FLORICOLA.

They are now (April 10th) quite lively. The remaining larva has also commenced to feed again.

These few observations tend to prove (1) that the larvæ of *C. aurata* feed for several seasons before reaching maturity; (2) that the imagines can hibernate and pass the winter in a quiescent state; (3) that all larvæ of the same age do not reach maturity together. These facts may account for the abundance or scarcity of this insect in certain seasons. Reference may also be made to the "Entomologist's Record," 1904, p. 301.

C. FLORICOLA, Herbst.

Last July my friend Mr. Horace Donisthorpe brought to the University Museum a larva of *C. floricola*, which he had obtained from a nest of *Formica rufa* in Scotland, in order that Professor Poulton might witness its remarkable mode of progression, afterwards described in "The Entomologist's Record," 1909, p. 288. This larva I have kept supplied with *F. rufa* nest material, and like *C. aurata* it has hibernated during the past winter. Having a larva of both species I thought it would be interesting to place them side by side and note the difference, if any, in their movements, &c. The comparison was made on April 13th last, when both larvæ were placed on a sheet of white paper and the following notes were made. With *C. floricola* it mattered not whether the larva was placed laterally or ventrally, it always turned over on to its dorsal surface, and with very slight contractions of the body moved along steadily and easily on a perfectly "even keel." In colour it is pale ochreous-yellow, almost straw-colour, and it is thickly covered with short, reddish-brown, bristly hairs. Its dorsal surface is not strongly convex, and the folds between its segments are arranged quite differently from those of *C. aurata*. These differences will be better appreciated by reference to the illustration. The latter is nearly white, and its dorsal surface is far more convex from side to side; it is less thickly covered with lighter-coloured hairs, which are chiefly developed on the sides. Its mode of progression differed in a marked degree from that of *C. floricola*. Like the latter it always turned over on to its dorsal surface, but its relatively rapid motion was accompanied by a pronounced roll, like that of a ship, due to the rounded contour of its back.

My thanks are due to my friend, Mr. C. J. Bayzand, for his kind assistance in photographing these larvæ.

University Museum, Oxford:
May, 1910.

NOTES ON THE EARLY STAGES

OF

HÆMONIA APPENDICULATA, PANZ.,

BY JOSEPH COLLINS.

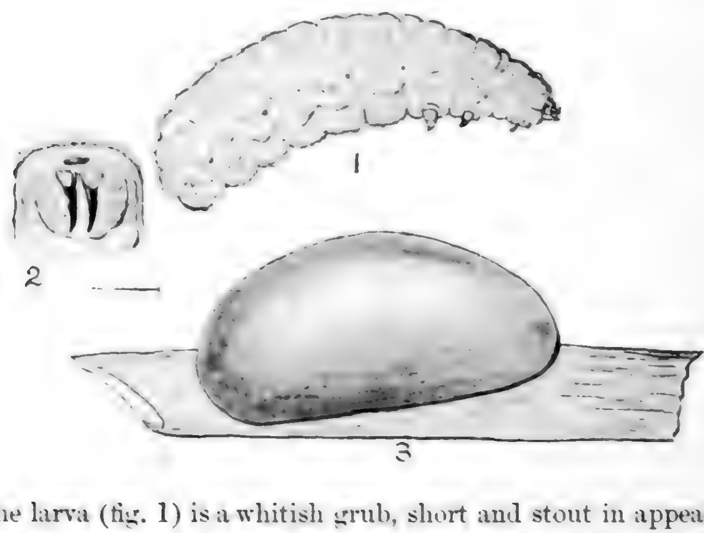
Reprinted from "The Entomologist's Monthly Magazine," 2nd Series, Vol. xxii.

During my holidays in the latter part of August, 1911, I devoted some considerable time to working with the water-net, in a mill-stream connected with the River Cherwell, near Oxford, for the rare *Hæmonia appendiculata*, Panz., the locality being that already recorded for the species, in E. M. M., vol. xlvi, p. 238. In the course of these operations, I came across a strange-looking larva suggesting that of a Dipteron in its appearance, among the water-weeds in my net. A day or two later, I noticed several peculiar little cocoons attached to the stems of an aquatic plant, among the *débris* which had become detached from the growing plants and had found their way into the water-net.

At the time I had no idea what these cocoons could be, and, therefore, took a few of them to see what they would produce. Visiting the place on another occasion, I found that one of these cocoons contained a fully developed imago on the point of emerging, there being a hole at one end. On closer examination, I was much pleased and surprised to see a perfect specimen of *H. appendiculata* inside, with legs and antennæ folded up snug and compact in this extremely small place.

I had thus traced the complete cycle of larva, pupa and imago.

The next thing to be done was to trace the beetle to its real food-plant, and this proved an unexpectedly easy matter. Wading into the stream, I pulled up a few plants and immediately found the cocoons attached to the stems, near the roots, of *Potamogeton pectinatus*. They have also occurred on an aquatic species of *Ranunculus*. The larvæ are decidedly gregarious, feeding at the roots of these plants in the mud at the bottom of the stream, sometimes six or eight of them occurring together in various stages, ranging from a quite small size up to full growth. From the cocoons brought home by me, two specimens of the beetle have emerged, one of which I assisted out by breaking open its cocoon, and have kept in a shallow dish of water with some of the weed since September 2nd, 1911. At the time of writing (October 6th), it is still alive. I hoped to determine the real time of appearance of the imago, but this I find very difficult to state at present. Towards the end of August I captured two pale immature-looking specimens which had evidently only just emerged. Throughout the period I was working for the *Hæmonia* the larva, pupa, and imago could be taken together, and on one occasion, when Commander Walker was present, I brought out of the water the three stages of the insect in a handful of the food-plant.



The larva (fig. 1) is a whitish grub, short and stout in appearance, convex on the dorsal, flattish on the ventral surface, wrinkled along the sides, and curved at each extremity. It is sparsely clothed on the dorsal and lateral regions with very short, bristly, ferruginous hairs, which are hardly visible except with a good lens, and look as if closely

shorn. On the anal segment is a very peculiar structure (fig. 2)—a pair of decurved spines or spurs, and at the base of each is a spiracle. The use of these singular appendages is very interesting, as stated in Prof. Miall's "Natural History of Aquatic Insects," p. 94, in his remarks on the larva of *Donacia*, which is very similar in habits and structure to that of *Hæmonia*:—"Roots of *Nymphæa* frequented by *Donacia* were observed by Schmidt-Schwedt* to exhibit peculiar scars. These were discovered with difficulty, owing to the dark colour and uneven surface of the roots. There was in each case a rough hole, made apparently by the jaws of the larva when feeding, and. at a distance corresponding with the length of the body, a pair of small slits. On microscopic examination, these slits were found to penetrate the epidermis of the roots. Something of this had been previously observed by Siebold, who in 1859 described the larva as biting a hole in the roots of *Sparganium*, passing the end of the abdomen into it, pressing the spiracles by the help of the curved spines close against the hole, and so drawing the containep air into its body. Schmidt-Schwedt believes that the pair of openings are made not by the mouth but by the spines, and that the air is drawn in by internal channels running along them."†

MacGillivray, in his paper on "Aquatic *Chrysomelidæ*,"‡ states that the larva of [*Hæmonia nigricornis*, Kirby] can be recognized from that of *Donacia* by having the sixth and seventh abdominal tergites each armed with a double row of setæ, most of which are twice as long as those found on the other tergites, and the supra-spiracular setæ wanting.

The cocoon (fig. 3) is subcylindrical; obtuse-ended, semitransparent, smooth and glassy looking, varying in colour from yellowish brown to darker brown. When the beetle is mature, its markings can plainly be seen through the semitransparent walls of the cocoon. The usual place of attachment is to the stems of the food-plant, a few inches above the roots, there being sometimes three or four cocoons on a stem. I have also found them at the roots spun up among the suckers. I am indebted to Commander J. J. Walker for the accurate drawings by Miss M. A. Sharp of the larva, breathing apparatus, and cocoon.

Oxford: *October 6th,* 1911.

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* Berl. Entom. Zeitschr., xxxi, pp. 325-334, Taf. v, figs. 1-11 (1887).

† Dewitz (Berl. Entom. Zeitschr., xxxii, p. 5, 1888) believes that in *Hæmonia*, and presumably in *Donacia* also, the spiracles serve for admission of air to the body as Siebold maintained. Schmidt-Schwedt has, B.E.Z., 1889, reaffirmed his original statement.

‡ Bull. N. York State Museum, 68, Entom. 18, p. 314 (1903).

From the Annals and Magazine of Natural History,
Ser. 8, Vol. x., *August* 1912.

Some Considerations in regard to the Classification of the Order Thysanoptera. By Richard S. Bagnall, F.L.S., F.E.S., Hope Department of Zoology, University Museum, Oxford.

Since my papers on the Urothripidæ were published *, I have come to the conclusion that in retaining that family as a family of the suborder Tubulifera unnecessary difficulties will be created. I have already shown that whereas *Urothrips* superficially resembles the Tubulifera very closely, it really differs from true Tubulifera more strongly in its structure than do the members of the suborder Terebrantia; or, in other words, the two suborders Tubulifera and Terebrantia are more closely related to each other than *Urothrips* to either. I am now convinced that the only course one can reasonably take is to erect a new suborder for the reception of the family Urothripidæ, for which I propose the name

POLYSTIGMATA,

suggested by the character that appears to me to be of the greatest taxonomic value.

It will be well to briefly diagnose the three suborders.

* Annales Musei Nationalis Hungarici, 1909, vii. pp. 125–136, pl. iii., & Mém. 1er Congrès International d'Entomologie, 1910, pp. 283–288.

Order THYSANOPTERA.

I. *Eleven pairs of stigmata present; hind pair of coxæ most widely separated; palpi single-jointed.* (Species bearing a close general resemblance to the Tubulifera; ocelli and wings absent; antennæ 7-jointed, joints broad and strongly characteristic; spiracular openings large and protected externally by specialized dorso-lateral papillæ; ninth abdominal segment elongated, longer than the preceding; intermediate terminal hairs obsolete.)

Suborder POLYSTIGMATA, mihi.

Containing the family *Urothripidæ*, Bagnall.

II. *Not more than four pairs of stigmata present; intermediate pair of coxæ most widely separated; palpi never less than 2-jointed.*

1. Female without an ovipositor; last abdominal segment tubular in both sexes (ninth abdominal segment not exceptionally elongated, and intermediate terminal hairs present; antennæ composed of eight more or less strongly elongated and slender joints *, certain of which bear one or more sense-cones). Lower and upper wings, when present, similar in structure, with only one median longitudinal vein, which is only partially developed, sometimes obsolete, and never reaches the tip of wing.

Suborder TUBULIFERA, Haliday.

Containing the diagnosed families *Phlæothripidæ*, Haliday, and *Idolothripidæ*, Bagnall.

2. Female with a saw-like ovipositor; last abdominal segment usually conical, that of male unlike the females and usually bluntly rounded. Fore wing with at least one longitudinal vein reaching from base to tip of wing. (The structure of the wings, palpi, antennæ, and ovipositor affords good characters for tabulating the families.) Suborder TEREBRANTIA, Haliday.

Containing the diagnosed families *Æolothripidæ*, Haliday, and *Thripidæ*, Haliday.

When Uzel monographed the Thysanoptera in 1895 the ultra-European species were unworked. Since then the North-American forms have received a good deal of attention, whilst material from tropical and subtropical regions is being received and dealt with. As a natural consequence, highly specialized forms and groups of species that cannot be regarded as members of the previously diagnosed families have been discovered, though the tendency with workers in the order has been to regard the three families Phlœothripidæ, Æolothripidæ, and Thripidæ as fixed and to fit new and specialized genera into one or the other. To eliminate difficulties as far as possible, I think it very desirable to make certain divisions and subdivisions to receive certain genera and groups, but shall be able to write more on this matter when I have had the opportunity of

* A few species possess 7-jointed antennæ, undoubtedly derived by the fusion of the seventh and eighth joints.

working out certain anomalous material now in my possession.

In the meantime I would recommend that the following specialized genera be regarded as the types of distinct divisions, which we may, for the moment, regard as families :—

TEREBRANTIA.

Heterothrips, Hood (nec Buffa) (THRIPIDÆ), on account of the structure and segmentation of the antennæ, the character of the sensoria, and the tarsal appendages. HETEROTHRIPIDÆ, mihi.

Panchætothrips, Bagnall (THRIPIDÆ), on account of the structure of the head, the abdomen, last abdominal segment and ovipositor in female, and venation of fore wings. PANCHÆTOTHRIPIDÆ, mihi.

Ceratothrips, Reuter, chiefly on account of the 6-jointed antennæ, which possess only a single-jointed style, the reduction in the antennal joints not being caused by fusion. CERATOTHRIPIDÆ, mihi.

TUBULIFERA.

Ecacanthothrips, Bagnall (PHLŒOTHRIPIDÆ), chiefly on account of the specialized antennal sense-cones congregated (in the form of numerous fingers) on the third antennal joint. ECACANTHOTHRIPIDÆ, mihi.

CEPHALOTHRIPS MONILICORNIS, Reut.: AN ADDITION TO THE *THYSANOPTERA* OF GREAT BRITAIN.

BY

RICHARD S. BAGNALL, F.L.S.

Reprinted from "The Entomologist's Monthly Magazine," 2nd Series, Vol. xxiii.

On the occasion of the British Association Meeting at Portsmouth last August, I had the opportunity of spending a few hours in the New Forest, taking many interesting thrips, chiefly belonging to the *Terebrantia*. But at Matley Bog a species of Tubuliferon, which I at once recognized as a *Cephalothrips*, occurred on long soft grass. Until 1910 only the apterous form was known; in that year, however, Fryderyk Schille [*Nowe Formy Przylzéncôw* (Thysanopterorum gen. et. spp. novæ)] in the "Academia Litterarum Cracoviensis" recorded a single female example of the winged form. This specimen, which Herr Schille later discovered (*in litt.*) was a male, has been generously submitted to me with other material described by him in the above mentioned paper.

Numerous specimens of *C. monilicornis*, Reut., were collected by Mr. C. B. Williams and myself in the New Forest, and although Williams obtained the fewer examples I was very pleased to learn that he had been fortunate enough to obtain two examples of the macropterous form, one of which he has kindly placed in my collection.

Cephalothrips monilicornis was first taken by Reuter in Finland, and has been more recently met with in Bohemia (Uzel), Poland (Schille), Italy (Buffa), and Norway (R. S. B.).

University Museum, Oxford:
July 6th, 1912.

[Reprinted from "The Scottish Naturalist," February 1913.]

NOTES ON SOME RARE THRIPS (*THYSANOPTERA*) FROM SCOTLAND.

By RICHARD S. BAGNALL, F.L.S., F.E.S., Hope Department of Zoology, University Museum, Oxford.

SINCE the publication of Haliday's *Epitome* in 1832 no attention whatever has been given by British entomologists to the study of these small but important insects until very recently. Of the species diagnosed by Haliday we recognise thirty-seven, but, since I first took up the group a few years ago numerous discoveries have been made, and the British list now stands at eighty-two species falling into thirty-four genera. I possess a good deal of material from the Clyde and Forth areas of Scotland, and smaller collections from the neighbourhood of Dundee, of Aberdeen, and of Nethy Bridge.

I trust that this material will be largely increased so that an account of the Scottish species may be attempted in the near future. Thrips are easily collected and preserved, and I should much like to correspond with collectors from all parts of the British Isles.

The following species, are, in the meantime, worthy of note:—

Sub-order TEREBRANTIA. Family THRIPIDÆ.

Amblythrips ericæ, Bagnall.[1]—Though the genus and species was diagnosed from material collected at Ravenscar, in Yorkshire, in the autumn of 1910, I have in my possession an example from Colintraive, in the Kyles of Bute, taken in July 1907.

[1] *Journ. Econ. Biology*, vi., 1911.

This autumn (1912), when its chief food-plant, *Erica tetralix*, was almost over, I found an adult specimen at Portlethen, near Aberdeen, and its larvæ on Bavelaw Moss, near Edinburgh. Owing to its larval-like form, *Amblythrips ericæ* is difficult to find, but is evidently of wide distribution; I have found it in many localities in Northumberland, Durham, and Yorkshire, in the New Forest, in the neighbourhood of Oxford, and at Blackgang Chine, in the Isle of Wight.

Oxythrips parviceps, Uzel.—Is not uncommon in various heaths in the Clyde Area. I have also taken it commonly at Portlethen, near Aberdeen, and on Bavelaw Moss, Midlothian, where Mr W. Evans, who recorded it from the Forth Area some years ago,[1] has also taken it.

[*Euthrips* (*Anaphothrips*) *orchidaceus*, Bagnall.[2]—On hothouse orchids I have taken it in the Glasgow Botanic Gardens (Dec. 1908), and the Rev. J. Waterston has sent me a lot of material from various orchids, Royal Botanic Gardens, Edinburgh.]

Aptinothrips nitidulus, Hal.—Island of Arran (1907); near Arrochar, at the head of Loch Long, July 1908; Ettrick Bay, near Rothesay, Bute, June 1911; at the head of Loch Goil, June 1912. On maritime plants.

Thrips juniperina (L.), Bagn.—I redescribed this form, which had been lost to Entomology for over a hundred years, in the *Journal of Economic Biology* (iv., 1909) from numerous specimens taken on Juniper in the forest round Nethy Bridge, and on the slopes of the Cairngorm, July 1908.

Thrips albopilosus, Uzel.—Rests as British on the strength of a ♂ and two ♀♀ taken with *T. juniperina* at Nethy Bridge, July 1908.

Sub-order Tubulifera.

Trichothrips pedicularius, Hal. — Taken by Mr Evans and myself from under *Corticium*, on an old Beech tree near Colinton, Midlothian, this autumn (1912).

Trichothrips propinquus, Bagnall.[3]—I have only recorded four specimens of this recently described species, all from the Derwent Valley, Co. Durham, and it was therefore particularly pleasing to me to find several in company with the *T. pedicularius* above recorded.

It struck me, therefore, that *Corticium* might be its proper

[1] *Proc. Roy. Phys. Soc.*, xvii., p. 55, 1909.

[2] *Ent. Mo. Mag.*, 2nd ser., xx., p. 33, 1909.

[3] *Trans. Nat. Hist. Soc. of Northumberland, Durham, and Newcastle*, N.S. iii., Dec. 1910.

habitat, and I recently searched both *Polystictus* and *Corticium* in Gibside, taking two more examples of *propinquus*, both from under *Corticium*.

Hoodia bagnalli, Karny.[1]—Mr Evans has sent me examples of this large and fine species from under Elm leaves, Dalmeny Park, Linlithgowshire, July 1909. My original specimens were taken in Teesdale and Derwent Valley, Co. Durham, and I have recently received specimens collected by Father Longinos Navas, in Spain. The species agrees very well with Uzel's description of *Liothrips hradicensis*, under which name I first recorded it. Prof. Karny of Vienna, however, has had the opportunity of examining Prof. Uzel's unique example in the Vienna Museum, and shows that my specimens differ structurally in the form of the mouth, and in the presence of certain bristles. The importance of the chætotaxy in the Thysanoptera was not realised when Uzel's work was written in 1895.

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RECORDS OF TWO RARE WOODLICE FROM THE FORTH AREA.

By RICHARD S. BAGNALL, F.L.S.

As the following Woodlice are not only regarded as somewhat rare (though I have found them to be widely distributed), but have not apparently been recorded from the Forth Area, I think their occurrence within that area worthy of note:—

TRICHONISCIDÆ.

Trichoniscus pygmæus, G. O. Sars.—Some years ago I met with a single example in the gardens behind Regent Terrace, Edinburgh. This autumn (1912) Mr W. Evans and I found it in a quarry near Swanston, at the foot of the Pentlands, where it ultimately proved to be plentiful. We also took a few examples on Arthur Seat whilst collecting *Scolopendrellidæ*. Mr Evans informs me he obtained it in 1907 at the Botanic Gardens, Edinburgh.

Haplophthalmus mengii, Zadd. — This sluggish form, which generally harmonises wonderfully with the stone to which it clings, is probably often overlooked.

[1] *Trans. Ent. Soc.*, London, 1912.

This autumn I met with single examples at South Queensferry, and in the quarry at the foot of the Pentlands; whilst, a few days later, Mr Evans and I found several examples on Arthur Seat, and a specimen in the woods near Colinton.

I might add that I have also recently taken both species at St Fort, near Dundee.

Reprinted from the Transactions of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne.—New Series, Vol. IV.

FURTHER RECORDS OF SOME BRITISH SYMPHYLA, WITH DESCRIPTION OF A NEW SPECIES.

By Richard S. Bagnall, F.L.S., F.E.S.

(Hope Department of Zoology, University Museum, Oxford).

(Overprints issued October, 1912)

Further Records of some British Symphyla, with description of a New Species.

By Richard S. Bagnall, F.L.S., F.E.S.

(Hope Department of Zoology, University Museum, Oxford).

Since my papers on the British species of this interesting Order were published I have had the opportunity of examining further material from various parts of Great Britain. This material consists of very many specimens collected by myself in the Wear and Derwent Valleys, in the Cheviot district and in Tynedale, and a few from Whitby, Oxford, the Clyde and Forth areas of Scotland, etc. Dr. Randell Jackson has submitted several interesting species, including examples of a new and distinct form of *Scolopendrella* from Cheshire, and Mr. Evans is now collecting material in the Forth area with his well-known energy and success. To these friends I would wish to express my warm thanks for allowing me to examine such interesting material, and also to Mr. Hirst of the British Museum for a tube of specimens from Devonshire.

The examination of such material has shown that many of the species I recently brought forward are not really uncommon, and are also of wide distribution.

The following table shows the distribution as at present known of the British species in the areas in which they have received at least moderate attention, each district or county (excepting Cheshire) being also subdivided to add to the interest of the table and local workers:—

SYMPHYLA	Scotland			Northumberland			Durham					Yorkshire (including Durham Tees records)			Cheshire
		Clyde	Forth		Cheviot	Tyne-dale		Coast	Der-went Valley	Wear	Tees		Coast	Inland	
SCUTIGERELLA															
S. immaculata (Newp.)	+	×	×	+	×	×	+	×	×	×	×	+	×	×	+
S. spinipes Bagn.	+	—	×	+	—	×	+	—	—	×	×	+	—	—	+
S. biscutata Bagn. ...	+	×	×	+	×	×	+	×	×	×	×	+	—	—	+
S. hanseni Bagn. ...	—	—	—	—	—	—	+	—	×	—	—	—	—	—	—
S. caldaria Hansen ...	+	×	—	+	—	×	+	—	×	×	—	—	—	—	—
SCOLOPENDRELLA															
S. notacantha Gerv. ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+
S. subnuda Hansen ...	+	×	×	+	×	×	+	×	×	×	—	—	—	—	—
S. isabellæ Grassi ...	—	—	—	—	—	—	+	—	—	×	—	—	—	—	—
S. dunelmensis Bagn....	—	—	—	—	—	—	+	—	×	—	—	—	—	—	—
S. jacksoni Bagn. ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+
S. horrida Bagn. ...	—	—	—	—	—	—	+	×	—	—	—	—	—	—	—
S. vulgaris Hansen ...	+	×	×	+	—	×	+	×	×	×	×	+	×	×	+
S. delicatula Bagn. ...	+	×	×	+	×	×	+	×	×	×	—	+	×	—	+
S. minutissima Bagn....	—	—	—	—	—	—	+	—	—	—	×	+	×	—	—

Of these districts Durham leads with twelve out of the fourteen known species, followed by Scotland, Northumberland, and Cheshire with seven each, and Yorkshire with six species. Cheshire possesses the two species *S. notacantha* and *S. jacksoni* not met with in County Durham, and there is no doubt that in all these areas, perhaps excepting Durham, more species await to be recorded.

Scutigerella immaculata (Newp.)

Several found with *S. biscutata*, *S. vulgaris* and *S. delicatula* in a garden, Chester, May, 1912 (A. Randell Jackson). Not uncommon in a dene between Blacklaw and Wooler Moor and on Westwood Moor near Wooler; and between Riding Mill and Stocksfield, Northumberland, May, 1912. Numerous specimens, Avonbridge, 13. iv. 12, and a single example from Manuel, East Stirling, 16. iii. 12 (W. Evans). Near Edinburgh, ix. 12 (W. Evans, R.S.B.). In the vicinity of Oxford.

Scutigerella spinipes Bagnall.

A few examples taken by Dr. A. Randell Jackson from his garden, Chester, April, 1912, and two examples (one with ten and the other with eleven pairs of legs) taken by Mr. Evans at Avonbridge, Stirlingshire, 13. iv. 12. I have myself met with further specimens this spring at Hylton and Penshaw, Co. Durham, and at Stocksfield, Northumberland.

These are the first records from Cheshire, Northumberland and Scotland, and an examination of this further material absolutely confirms my opinion as to the validity of the species, which is easily recognized by the characters named in my diagnosis. It is probably a moderately common form.

Scutigerella biscutata Bagnall.

This distinct form has occurred several times in the neighbourhood of Fencehouses and Penshaw, whilst I have taken examples in a quarry near Hylton, on the sea banks at

Blackhall Rocks, Co. Durham; on Westwood Moor near Wooler, and in a Newcastle garden, Northumberland. More recently from Gibside in the Derwent Valley.

Dr. Randell Jackson has submitted several examples from his garden, Chester, and a single specimen from Dringle, Cheshire, May, 1912. I have more lately received an immature example with only 8 pairs of legs taken by Mr. Evans at Avonbridge, Stirlingshire.

First records from Northumberland, Cheshire and the Forth area of Scotland.

Scutigerella caldaria Hansen.

In the Winter Gardens, Sunderland, and the Botanical Gardens at Oxford.

First record for Oxfordshire.

Scolopendrella subnuda Hansen.

Northumberland.—Several with *S. delicatula* in the hills at Skirlnaked near Wooler, and in a garden near Stocksfield-on-Tyne.

Durham.—On the sea banks at Blackhall Rocks, in the vicinity of Penshaw, and at Gibside and Winlaton Mill.

Oxfordshire.—In gardens at Oxford, several examples, November, 1911.

Devonshire.—Several examples taken by Mr. Hirst of the British Museum.

Scotland.—A single example taken by myself near Queensferry in the Forth area.

These are the first records for Northumberland, Oxfordshire, Devonshire, and the Forth area of Scotland.

Scolopendrella dunelmensis Bagnall.

S. isabellæ var. *dunelmensis* Bagnall.

Occurs frequently in its original habitat at Gibside and at another place about three-quarters of a mile away.

Scolopendrella jacksoni sp. nov.

Allied to *isabellæ* Grassi and *dunelmensis* Bagn., of about the same size and build, and differing in the chætotaxy of the scuta, legs and cerci.

The legs of the last pair have only two long protruding dorsal setæ on the metatarsus, and not more than four similar setæ on the tarsus, whilst the recumbent hairs are almost as long as the erect ones.

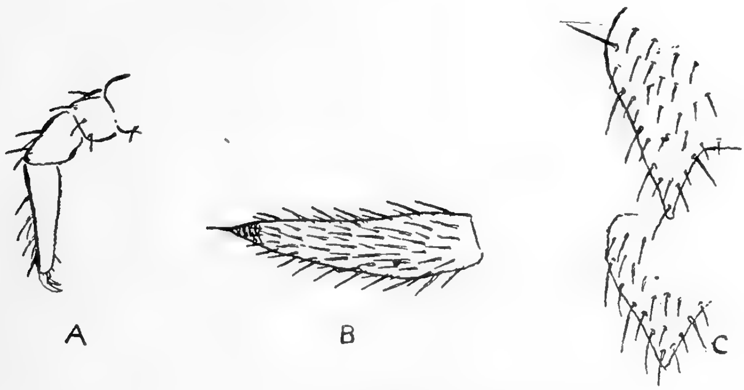

Fig. 1. *Scolopendrella jacksoni* sp. n.

A. Left hind leg.
B. Lateral view of cercus.
C. Left side of 2nd and 3rd dorsal scuta.

The setæ of the cerci are slightly fewer and distinctly longer than in either *isabellæ* or *dunelmensis*. The scuta possess several long prominent bristles on the lateral margin and on the *inner margin* of process also. In the allied species there are no such long setæ on the inner margins of processes. The lateral margin of the second scutum has five long prominent setæ, including the antero-lateral and apical ones, and the inner margin of the process is furnished with two such setæ.

Distribution.—Several examples taken by Dr. A. Randell Jackson at Saltney Ferry, Cheshire, in the spring of this year. I have much pleasure in naming the species in honour of its captor.

Scolopendrella vulgaris Hansen.

I am able to add the following localities, in addition to those already recorded, viz., on the sea-banks near Whitby, Yorkshire; in a quarry at Hylton, April, 1912; and in gardens at Oxford, November, 1911. Dr. Randell Jackson has met with the species in his garden, Chester, and also at Queensferry. Mr. Evans and I have taken the species in the neighbourhood of Edinburgh, whilst I have an example from the head of Loch Lomond, near Ardlui.

First records for Cheshire and Oxfordshire and the Forth area of Scotland.

Scolopendrella delicatula Bagnall.

Though scarce, this slender little species is apparently widely distributed.

Further examples have occurred in the Fencehouses and Penshaw habitats, and in a garden near Fellside in the Derwent Valley. In April, 1912, Dr. Randell Jackson obtained a few examples in his garden at Chester, whilst I discovered several on the sea-banks near Whitby, Yorkshire, and in May, 1912, I found it sparingly with *S. subnuda* in the hills at Skirlnaked near Wooler. In July, 1912, I found a solitary specimen in the gardens of the Hancock Museum. Whilst collecting Protura, etc., with me in a quarry near Edinburgh, Mr. Evans found a pair of this animal, whilst I believe it is represented in a rather large collection of Scolopendrellids made by us on Arthur's Seat. I have not yet had the opportunity of examining this latter material.

I have also taken a specimen on the banks of Loch Lomond near Ardlui.

First records for Cheshire, Yorkshire and Scotland.

FROM

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[*Reprinted from* 'The Zoologist' *for July, 1912.*]

BRIEF RECORDS OF *CHÆTECHYLENE VESUVIANA*, Newp., AND OTHER MYRIOPODS NEW TO THE BRITISH FAUNA.

By Richard S. Bagnall, F.L.S.
(Hope Department of Zoology, University Museum, Oxford.)

Some years ago Dr. Randell Jackson sent me a collection of Chilopods made by him at Sidmouth, in Devonshire, amongst which were four specimens of a large Geophilid. I recently submitted these to Mr. Edw. Ellingsen, of Kragerö, Norway, who reported that he had not seen the species before, suggesting that it might be *Chætechylene vesuviana*. Prof. Verhoeff has since seen the specimen, and writes that they are undoubtedly that species.

Chætechylene vesuviana (Newp.).

Geophilus vesuvianus, Newport, Trans. Linn. Society, London, xix. p. 435, 1844.

The species is described fully by Latzel in his 'Die Myriopoden Osterr.-Ungar. Monarchie' on page 201, from which it will be seen that the species differs in many particulars from *C. montana*, Meinert.

C. montana rarely exceeds 30 mm. in length by 1·4 mm. in breadth, whilst *C. vesuviana* measures up to 52 mm. by 2·5 mm. in breadth; the former possesses 57 to 61 pairs of legs in the female and 55 to 59 in the male; and the latter 63 to 75 in the female, and 61 to 77 in the male. Other points to note in Latzel's description are as follows:—

C. vesuviana.	C. montana.
Pori anales duo, minimi. Spiracula sat magna, rotunda. Pedes anales . . . femina tenues, maris crassissimi.	*Pori anales evanidi. Spiracula sat parva, rotunda. Pedes anales . . . femina tenues, maris incrassati.*

The species was originally described by Newport from the slopes of Vesuvius, and must apparently be classed in that group

of Lusitanian forms of which examples appear in this country in the south-west of England and in Ireland.

In collecting material towards an account of the Myriopods of Northumberland and Durham, I have brought to light several interesting forms previously unrecorded as British.

The Symphyla and Pauropoda have already formed the subject of several papers, and I now think it advisable to briefly record the following Chilopods and Diplopods :—

Chilopoda.

Lithobius nigrifrons, Latz. Two examples from Gibside, Co. Durham, 1906; unfortunately so mutilated as to make the positive identification impossible.

L. borealis, Mein. Rests as British on a mutilated specimen found by Mr. Evans on Ben Ledi. Wooler Moor, one male and one juvenile; Skirlnaked, near Wooler, Northumberland, one male and one female, May, 1912; Ben Vorlich, one female, June, 1912.

Diplopoda.

Glomeris marginata, Vill., var. *perplexa*. Two specimens on the Durham side of the Tees, Egglestone-in-Teesdale, and a few from Gibside. A small, purplish form marked with yellow, as in *G. connexa*, C. K.

Polydesmus coriaceus, Porat. One male from a mole's nest, Bradbury, Co. Durham. Two young specimens are probably referable to the same species.

Titanosoma jurassicum, Verh. Recently described from a single female found at Kelheim, on the Danube. I have found it in large numbers in a dene near Fencehouses, and single examples on the Wear at Penshaw, and in Gibside. Since then I have seen it in gardens at Penshaw, Hylton, Gibside, and Fellside, Co. Durham, Newcastle, and Oxford, whilst Dr. Randell Jackson takes it not uncommonly at Chester.

Brachychæteuma bagnalli, Verh. One male, Gibside, Co. Durham. This blind species is the type of a new genus and family. Prof. Verhoeff has already briefly described it in the Zool. Anzeig., whilst a very complete account will appear shortly in

the 'Transactions of the Natural History Society of Northumberland and Durham.'

Microchordeuma sp. One female, Gibside.

Craspedosoma simile Verhoeff; *C. simile rhenanum* Verhoeff. Both these forms occur in Gibside, where I first took them in the spring of this year.

Isobates varicornis, C. K. Common under fir-bark, Gibside, May, 1911, and June, 1912, one female; Harbottle, June, 1911; and Stocksfield, Northumberland, June, 1912.

Napoiulus sp. (most probably *palmatus*, Nemec.). Several females from a dene near Fencehouses, Co. Durham.

British representatives of the genera *Titanosoma*, *Brachychæteuma*, *Microchordeuma*, *Isobates*, and *Napoiulus* were previously unknown.

THE POCKET-BOOK OF BRITISH BIRDS.

By E. F. M. Elms. *With description of British species and distinguishing characters; habits: food; language or song: nest and eggs. Foolscap 8vo, Cloth, gilt top, 160 pp. + blanks for Notes. Price 2s. 6d., postage 2d.*

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"We have nothing but good words to say of the excellent writing and capital pictures in colour and black-and-white which Mr. Arnold has given us of the birds, and where and how to find them."—*Illustrated Sporting & Dramatic News.*

"It is most entertainingly written, full of good stories and of useful hints. . . . Mr. Arnold's illustrations, most of which are coloured, are both beautiful and true to life, and altogether the work of this genial sportsman can be confidently recommended not only to those amateur collectors and shore-shooters to whom it is dedicated, but to all such as feel inclined to extend their acquaintance with Natural History. It is a book which it would be hard to better and impossible to supplant."—*Morning Post.*

Notes towards a Knowledge of the Clyde Myriapoda.

By Richard S. Bagnall, F.L.S., F.E.S.

(Hope Department of Zoology, University Museum, Oxford).

[Read 25th March, 1913.]

I have never made any systematic attempt to collect the Myriapods in the Clyde area, but as only thirteen species are recorded in the British Association Handbook of the Fauna of that Area, I think my few records should be published, and perhaps others will take up the special study of these creatures.

Most of my material was taken during a short holiday at Rothesay, including a day at Ormidale and another at Brodick, and in the spring of 1912, a week-end at Ardlui added some interesting species, notably *Lithobins borealis* Mein., and a recently described species of *Scolopendrella.* That much work remains to be done in the Myriapods of this country is beyond doubt. In little more than a season's collecting in the Northumberland and Durham district, I brought to light over sixty species, including more than twenty additions to the British fauna. These results were largely due to a special study of the two obscure groups, the Pauropoda and the Symphyla, but at the same time, notable captures amongst the larger forms were also made, such as *Brachychæteuma bagnalli* Verhoeff, the type of a

new family, *Titanosoma jurassicum* Verh., in numbers; *Craspedosoma simile* Verh.; *Isobates varicornis* C.L.K.; *Polydesmus coriaceus* Porat, &c., &c. I have received much help in the identification of the Chilopoda and Diplopoda proper (groups that I cannot pretend to have studied closely), from Mr. Ed. Ellingsen, of Kragerö, and Professor Verhoeff, of Munich.

Thirty-four forms are noted below. Those marked with an asterisk are not recorded in Mr. Boyd's Clyde list, whilst his list includes *Julus pusillus* Leach, *Craspedosoma rawlinsii* Leach, *Atractosoma polydesmoides* Leach (perhaps the *Polymicrodon* recorded below,) and *Stigmatogaster subterraneus* Leach, not recorded by me.

Order Chilopoda.

Lithobiidæ.

Lithobius forficatus, L.—Ormidale, one young; Rothesay, common; Lochgoilhead, Ardlui, &c.

Lithobius variegatus, Leach.—One ♂ and one ♀, Rothesay.

**Lithobius glabratus*, C.L.K. (*L. melanops* Newp.)—Under loose bark of fir stumps, Ormidale and Lochgoilhead.

**Lithobius crassipes*, C.L.K.—Common, two ♂s, one ♀, one young. Rothesay; four ♂s, two ♀s, one young, Ardlui; Lochgoilhead.

**Lithobius borealis*, Meinert.—One ♀ near summit of Ben Vorlich.

**Henicops fulvicornis*, Meinert.—One young, Rothesay.

Scolopendridæ.

**Cryptops hortensis*, Leach.—In the Botanic Gardens, Glasgow.

Geophilidæ.

Geophilus longicornis, Leach. (*G. flavus* De. G).—No doubt common, Rothesay and Ardlui.

**Geophilus proximus*, C.L.K.—Near Ormidale, a few examples.

**Geophilus carpophagus*, Leach.—Several examples from

Ormidale; one ♂ (47 p.l.) two ♂s (49 p.l.) and three ♀s (51 p.l.) from the slopes of Ben Vorlich.

**Geophilus truncorum*, Bergs. & Mein.—A small but not uncommon species, one specimen, Ormidale; two ♀s and one young from the foot of Ben Vorlich.

**Schendyla nemorensis*, C.L.K.—Two ♂s (39 p.l.) and one ♀ (41 p.l.), from the slopes of Ben Vorlich.

**Scolioplanes maritima*, Leach. — Probably widely spread throughout the area. I have seen and taken it in some numbers at Ormidale, Colintraive, and Lochgoilhead.

**Mecistocephalus carniolensis*, C.L.K.—In the Botanic Gardens, Glasgow.

Order Pauropoda.

PAUROPODIDÆ.

**Allopauropus gracilis*, Hansen. — One example, Ardlui. Other species will be found if special attention is given to this interesting group. I have taken six species in the County of Durham.

Order Symphyla.

SCOLOPENDRELLIDÆ.

**Scutigerella immaculata*, Newp.—With *Symphylella vulgaris* in a field near Rothesay.

**Scutigerella biscutata*, Bagnall.—On the Clyde near Bishopton, one example.

**Hanseniella caldaria*, Hansen.—In hothouses, Botanic Gardens, Glasgow.

**Scolopendrellopsis subnuda*, Hansen.—One specimen from under a stone near Brodick, Arran. Unfavourable weather prevented further search.

**Symphylella delicatula*, Bagnall.—A single specimen from under a stone on the shore of Loch Lomond near Ardlui.

**Symphylella vulgaris*, Hansen.—One specimen, Bishopton, on the Clyde, and several from under stones in a field near Rothesay.

Order Diplopoda.

GLOMERIDÆ.

Glomeris marginata, Vill.—I have noticed this species in many Clyde localities.

**Glomeris marginata* var. *perplexa*.—One example, Ormidale. This distinct little form, recently recorded by myself from Durham, is referred by Verhoeff to the var. *perplexa* of *G. marginata*, whilst another authority refers it to *G. connexa* C.L.K. It agrees very well in colour pattern with *connexa*, but is only about one-third the size of examples in my collection. It is also very much smaller than typical *marginata*.

POLYDESMIDÆ.

Polydesmus complanatus, L.—Not uncommon. Though I have only bottled a few specimens (2 ♂s from Rothesay), I have seen the species in many localities.

**Polydesmus denticulatus*, C.L.K. — Two ♂s and young, Rothesay; one ♂, one ♀, and young, Ben Vorlich.

**Orthomorpha gracilis*, C.L.K.—In hothouses very common, Glasgow.

**Brachydesmus superus*, Latzel.—Ardlui, several examples under holly bark; two ♂s, two ♀s, and young, Rothesay.

CHORDEUMIDÆ.

**Polymicrodon latzeli*, Verh.—One example from Rothesay.

JULIDÆ.

Julus sabulosus, L.—Near Ayr, Rothesay, Ardlui, &c.

Julus albipes, C.L.K.—Common.

Julus punctatus, Leach (*J. silvarum* Mein.)—Also common.

**Julus fallax*, Meinert.—One ♀, Rothesay.

Blanjulus guttulatus, (Bosc.)—Common, Shandon, Rothesay, Glasgow, Ayr, &c.

**Blanjulus fuscus*, Am. Stein.—Seven ♀s, Ardlui.

**Blanjulus pulchellus*, Koch.—Several specimens from the Botanic Gardens, Glasgow, are almost certainly referable to this form.

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EXTRACTS FROM THE PROCEEDINGS

OF THE

ENTOMOLOGICAL SOCIETY OF LONDON

(MARCH 2ND—DECEMBER 7TH 1910.)

Wednesday, March 2nd, 1910.

 Exhibitions.

Professor E. B. POULTON, F.R.S., read the following—

PRELIMINARY NOTE ON MR. A. D. MILLAR'S EXPERIMENTAL BREEDING OF FORMS OF THE NYMPHALINE GENUS *EURALIA* IN NATAL.—By ROLAND TRIMEN, M.A., F.R.S.

There are three forms of *Euralia* which inhabit the coast-land of Natal, vid. *E. wahlbergi*, Wallengr., *E. mima*, Trim., and *E. deceptor*, Trim. The first and second of these, without being numerous, are met with not uncommonly; the third, first brought to notice in 1869, and described by me in 1873 from a single ♂, has hitherto remained very rare in the Colony. Each of the three forms in both sexes unmistakably and very closely mimics a Danaine of the genus *Amauris* prevalent in the same district:—thus, *E. wahlbergi* mimics *A. niavius*, sub-sp. *dominicanus*, Trim.; *E. mima* mimics *A. albimaculata*, Butl., as well as *A. echeria*, Stoll.; and *E. deceptor* mimics *A. ochlea*, Boisd. The intimate affinity of the three *Euraliae* is apparent, although their wing colouring and marking present such wide differences. To this I called attention when describing (Trans. Ent. Soc., 1873, p. 107 and foot-note) *E. deceptor*, as well as to the fact that *E. mima* ♂ and *E. wahlbergi* ♀ had been taken paired.* Since then Mr. A. D.

* See also "South Afr. Butt.," I, pp. 282, 283 and 285 (1887).

Millar, Mr. C. N. Barker, Mr. Guy A. K. Marshall, Mr. G. F. Leigh, and other entomological observers in Natal have brought to notice several other cases of the pairing of these two forms, and also various details of habits, distribution, etc., which supported the view of their species-identity. Recently Mr. Millar, having discovered the foodplant—a stinging-nettle recognised by Mr. J. Medley Wood as a species of *Fleurya*—has been enabled to test matters by breeding from ova laid respectively by a *wahlbergi*, a *mima*, and two *deceptor*. These four ♀ ♀ were all taken towards the end of March 1909—the *wahlbergi*

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and the two *deceptor* on the 21st, and the *mima* between that date and the 26th.

The results were as follows, viz.—

(*a*) From 10 ova laid by one *wahlbergi* were bred 4 *wahlbergi* (2 ♂ ♂, 1 ♀, 1 deformed, sex undetermined), and 5 *mima* (4 ♂ ♂, 1 ♀).

(*b*) From 39 ova laid by one *mima* were bred 33 *mima* (24 ♂ ♂, 9 ♀ ♀).

(*c*) From 139 ova laid by two *deceptor* were bred 127 *deceptor* (70 ♂ ♂, 57 ♀ ♀).

Experiment (*a*) proves the species-identity of *wahlbergi* and *mima*; while experiment (*b*) seems to indicate the probable predominance—as in the case of the ♀ forms of *Papilio dardanus*, sub-sp. *cenea*—of the models *Amauris echeria* and *albimaculata* in affecting the mimetic pattern and colouring.

Experiment (*c*) affords no evidence of *deceptor* belonging to the same species as the other two forms, all the bred examples of both sexes being recorded by Mr. Millar as true to type.

The case of *Euralia wahlbergi* and *mima* is in agreement with that of *Charaxes zoolina* and *neanthes** as regards the dimorphism including both sexes; but there is a striking difference to be observed, in that the double mimicry so highly developed in both sexes of the *Euralia* finds no place in the *Charaxes*, whose colouring in both forms, but especially in *neanthes*, is by no means conspicuous and on the under-side apparently cryptic.

* See Mr. G. F. Leigh's interesting account (Proc. Ent. Soc. Lond. for 21st October, 1908, p. lxiv, and 6th October, 1909, p. xlix) of his experimental breeding of these forms from the ova.

Mr. Millar has furnished photographs of the three sets of *Euralia* progeny bred by him, with many most valuable details as to transformations, etc., and also a selection of specimens of the larvae, pupae, and imagines. With all these data I propose to deal fully in a later communication to the Society.*
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Professor POULTON reminded the Fellows of Mr. Guy A. K. Marshall's conclusion that *E. wahlbergi* and *mima* were forms of the same species (Trans. Ent. Soc. Lond., 1902, pp. 491, 492), and of the exhibition of specimens relied on as evidence (June 6, 1906 : Proc. Ent. Soc. Lond., 1906, pp. liii, liv). He felt that Mr. A. D. Millar was to be greatly congratulated on his success in obtaining this long-wished-for proof of a most important and probably far-reaching conclusion.

Professor POULTON considered that the uniform offspring of the *mima* parent (*b*) could not be explained in the same manner as the predominant *cenea* offspring of *P. dardanus* in Natal; for according to Mr. G. F. Leigh (Proc. Ent. Soc. Lond., 1906, p. lvii) *mima* is the rarer of the two forms in Natal, whereas in the same area *cenea* is by far the commonest of the *dardanus* females.

The comparison of the results obtained by Mr. Millar in (*a*) and (*b*) suggested a Mendelian relationship between the two forms.† It was interesting to compare the records of two broods obtained from *Hypolimnas misippus* (Proc. Ent. Soc. Lond., 1909, pp. xxxvi, xxxvii).

Professor POULTON also exhibited a set of 6 *Euralia anthedon*, Doubl., and 4 *E. dubia*, Beauv., captured in the same locality, Oni, 70 miles east of Lagos, by Dr. W. A. Lamborn (Dec. 1908–

* Since the meeting on 2nd inst., I have received from Mr. A. D. Millar the result of a *second* experiment in breeding from the ova of the *mima* form, differing remarkably from that of the first (*b*) described above. From a ♀ *mima's* 11 ova, laid on 21st November, 1909, were bred 8 *mima* (5 ♂ ♂, 3 ♀ ♀) and 3 *wahlbergi* (♂ ♂). This rounds off the case very satisfactorily. As in result (*a*), the *wahlbergi* and *mima* of this last family are respectively all true to type, and not one example is at all intermediate between the two forms.—R. TRIMEN, March 15, 1910.

† Since the date of the meeting I have had the chance of discussing the facts with Mr. L. Doncaster, who agrees that the two forms are probably a Mendelian pair, but considers that we have not at present sufficient evidence to decide whether *wahlbergi* or *mima* is dominant. Mr. Doncaster agrees that the last result, recorded by Mr. Trimen in the foot-note for p. xv, makes it probable, but by no means certain, that *mima* is the dominant.—E. B. POULTON, March 21,1910.

Dec. 1909). *Anthedon* was the western representative of *wahlbergi*, *dubia* of *mima*, and now, after the proof obtained by Mr. Millar, it became almost certain that the western butterflies also were the dimorphic forms of a single species. He trusted that Dr. Lamborn would be able to obtain indisputable proof of this conclusion.

Professor POULTON considered that it was convenient at this point to correct an error for which he was responsible in Rev. K. St. Aubyn Rogers' paper in Trans. Ent. Soc. Lond., 1908, p. 489. *Euralia kirbyi*, Butl., mentioned and figured (Pl. XXVII, fig. 5) in this memoir, was not a distinct species, but the male

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of *E. deceptor*, Trim. The specimens sent by Mr. St. Aubyn Rogers had been compared with the British Museum collection in 1907, when the males stood under *kirbyi*, the females under *deceptor*. When, however, in 1909, a number of the specimens of *deceptor* bred by Mr. Millar were examined, the error became manifest. In the mean time the mistake had been independently detected and set right in the collection of the British Museum. The male of *E. deceptor* was described by Mr. Trimen in Trans. Ent. Soc. Lond., 1873, p. 105, and both sexes in "South African Butterflies," 1887, I, p. 286. The male was described by Dr. A. G. Butler as *kirbyi* in P.Z.S., 1898, p. 51.

Professor POULTON exhibited the female of *Apaturopsis cleocharis*, Hew., taken Feb. 1, 1909, by Mr. C. F. M. Swynnerton on the outskirts of Mt. Chirinda Forest (3,800 ft.), Melsetter, Gazaland, S.E. Rhodesia. The exhibitor did not know of another example of the female of this rare butterfly, which differs from the male to a remarkable extent, being far larger and possessing a rounded hindwing without the produced anal angle which is so characteristic of the opposite sex. Professor Poulton also exhibited an example of the male captured by Mr. G. A. K. Marshall, Oct. 19, 1905, in the same locality.

Paper.

The following paper, also, was read :—

"Third Paper on the *Tetriginae* (Orthoptera) in the Oxford University Museum," by J. L. HANCOCK, M.D.

xxxi] Wednesday, May 4th, 1910.

EDIBILITY OF LEPIDOPTEROUS LARVAE.—Mr. H. ELTRINGHAM stated that in reference to his previous paper describing experiments on the edibility of certain lepidopterous larvae (Trans. Ent. Soc., 1909, pp. 471–478), the caterpillars there referred to as *Boarmia rhomboidaria* had proved to be *Odontopera bidentata*. Further, that some of the moths had been bred from larvae fed exclusively on ivy, and though similar larvae had, as explained in the paper referred to, proved extremely distasteful to the lizards with which he had experimented, the moths were found to be palatable.

His lizards having failed to survive the winter, he had sent the moths to the Zoological Gardens, where Mr. Pocock had
xxxii]
given one to a bird and two to some lizards, *Lacerta viridis*. The result was described by Mr. Pocock as follows:—

"Commander J. J. Walker sent me, about a week ago, one of the moths you are interested in, and I gave it to a bird, a black-winged Grackle (*Graculifica melanoptera*), a kind of starling from Java. I have tested this bird before with insects and have known him reject some which other birds will eat, thus showing that he is to a certain extent fastidious and not like some birds which will eat almost anything, He took it at once and after pecking it and pulling it about for a little time, swallowed it. He showed no sign of finding the moth in any way distasteful—that is to say, he did not once wipe his beak, or shake his head, or behave as other birds do when they taste anything nasty. Having confidence in his powers of discrimination, I had no hesitation in concluding the moth to be palatable.

"This was borne out by my experiment with the two you sent me this morning. I threw one into a cage of green lizards. One of them seized it at once and swallowed it in ten seconds. I then threw in the other hoping that a second lizard would take it, but the first was on to it in a moment and ate it as soon as ever he had adjusted it in his mouth so as to swallow it head first. I noticed that he squeezed some fluid out of its

posterior end, but even when this came into contact with his palate and tongue he gave no sign of tasting anything disagreeable. The lizards were *Lacerta viridis.* There was a saucer half full of mealworms in the lizards' cage, so there is no reason to suppose that they were specially hungry."

Mr. ELTRINGHAM added that he was greatly indebted to Mr. Pocock for so carefully carrying out and recording the experiment. The result appeared to show that the distastefulness of the larvae was due to the particles of the foodplant contained in the digestive tract. The inedibility, though not in this case due to peculiar properties elaborated by the metabolism of the larva, might nevertheless, under conceivable circumstances, have considerable importance for the larva itself. Distastefulness must have a beginning, and so long as it was a question of surviving or being eaten, the fact rather than the cause of the inedibility would be of first importance.

Wednesday, June 1st, 1910.

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ERROR IN THE ACCOUNT OF MR. LEIGH'S BREEDING EXPERIMENT WITH CHARAXES (Proc. Ent. Soc., Lond., 1909, p. xlix).

Professor POULTON, F.R.S., who was unable to be present, sent the following correction of an unfortunate error which has crept into the Proceedings of last year :—

"Mr. Leigh is stated, on p. xlix, to have exhibited the ♀ parent and 21 specimens of the offspring of *Charaxes zoolina neanthes.*

"On the other hand, it is also stated that 'the ova deposited by the *zoolina* form of the ♀ . . . produced 4 ♂ ♂ s and 2 ♀ ♀ s like the parent, and 15 ♂ ♂ s and 9 ♀ ♀ s of the *neanthes* form,' or 30 offspring in all. I have examined the specimens, which are now in the Hope Department, and find 21 offspring, but also observe that there are among them 6 and not 15 ♂ ♂ s of the *neanthes* form. It is to be hoped that this correction will meet the eye of any naturalist who has been interested in the published statement."

xlii] *Paper.*

"On the Specific Distinctions between *Acraea lycoa*, Godt., and *Acraea johnstoni*, Godm.," by HARRY ELTRINGHAM, M.A., F.Z.S.

Wednesday, November 2nd, 1910.

lxiv] *Paper.*

Professor E. B. POULTON, D.Sc., M.A., F.R.S., communicated a paper entitled "Experiments with the larva and pupa of *Uropteryx sambucaria* in connection with their Colour Surroundings," by ELIZABETH BRIDGES.

Wednesday, December 7th, 1910.

lxxi] *Exhibitions.*

Commander J. J. WALKER exhibited *Conops signata*, Wiedemann, ♂ and ♀, a Dipteron new to Britain, taken at Tubney, Berks, September 11th, 1910, and exhibited on behalf of the captor, Mr. Joseph Collins, of the Oxford University Museum.

EXTRACTS FROM THE PROCEEDINGS

OF THE

ENTOMOLOGICAL SOCIETY OF LONDON

(MAY 3RD—DECEMBER 6TH, 1911).

Wednesday, May 3rd, 1911.

Papers.

xxvi]
COMMANDER WALKER, one of the Secretaries, communicated the following papers:—

"Some African and a few Australian Aculeate Hymenoptera in the Oxford Museum," by the late Col. BINGHAM, with a prefatory note by Prof. POULTON; communicated by ROWLAND TURNER.

Wednesday, June 7th, 1911.

Exhibitions.

BARYPITHES PELLUCIDUS.—Commander J. J. WALKER exhibited specimens of *Barypithes pellucidus*, Boh., from Oxford,
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Enfield, and Tavistock respectively, and for comparison, *B. duplicatus*, Keys, from the Blean Woods and Birchington, Kent.

Mr. F. B. JENNINGS remarked that he took *B. pellucidus* on buttercups and inquired whether any were present where these specimens were taken. Commander WALKER replied that there were no flowers at all, only short grass, in the locality where his Oxford specimens were taken.

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HEMIPTEROUS MIMICS OF HYMENOPTERA.—Prof. POULTON exhibited on behalf of Mr. A. H. HAMM, assistant in the Hope Dept. of the Oxford University Museum, a case of

insects illustrative of certain associations of mimetic British Hemiptera-Heteroptera with their Hymenopterous models, and communicated the following paper from him:—

"The examples of mimicry mentioned below may be well known to entomologists: certainly the ant-like appearance of *Nabis* has been often described. My chief object is to record the fact that the Hemiptera are to be found in the localities frequented by their models, and often in their company. Field observations are especially important in the mimics of insects, such as the Hymenoptera Aculeata, with extremely characteristic habits and movements.

"*Alydus calcaratus*, L.—During one of my visits to S. Devon (August, 1899), I was collecting Aculeates on and about the heather at Bovey Tracey, and took what I thought was a Pompilid. On looking into the net I was surprised to

see nothing but an ordinary-looking, although very active, Coreid bug. While still watching it running about the net, the bug opened its wings to take flight, and exposed the bright red patch which covers two-thirds of the abdomen. The resemblance which had at first deceived me is not, however, solely due to the colouring; for the short, jerky flight and manner of running in and about the herbage, so characteristic of the Pompilidae, is also a marked feature in the movements of *A. calcaratus*. The bug is also to be found in the localities haunted by the *Pompilidae*. Within a few yards of the spot where I netted the above specimen and on the same day (Aug. 10th, 1899), I captured a ♀ *Pompilus viaticus*, L. Again, in the New Forest, on Aug. 14th, 1908, I captured an example of *A. calcaratus* and *Salius exaltatus*, F. ♀ in close proximity. On many other occasions, but always in sandy, heathy localities, I have seen this Coreid mimic, and its Pompilid-like movements and appearance have invariably attracted my attention.

"The observations recorded above refer to the mature insect: I now propose to speak of the earlier stages. On a sand-bank just outside Beaulieu Road Station, in the New Forest, I observed (Aug. 10th, 1908) what I at first mistook for *Formica rufa*, L. Knowing, however, that the ant is not

found in this spot my curiosity was aroused, and looking more closely I saw that the insect was an immature bug. Within a short distance several other examples were found. These Mr. E. A. Butler has kindly determined for me as very young specimens of *A. alcaratus*, L. In this stage the bugs are remarkably ant-like, resembling most closely the common *F. rufa*, although at Beaulieu they were running about in company with *Formica fusca*, Latr., race *fusco-rufibarbis*. This latter ant, which was very abundant, itself somewhat resembles a small dark *F. rufa*. On Aug. 14th I found another immature *Alydus* in the same spot under precisely similar conditions.

"We thus see that the same species of bug, in two different phases of its life-history, mimics forms belonging to two widely-separated families of the Hymenoptera.

"*Pilophorus*, sp.—I have also had various opportunities of observing two other species of Heteroptera which are remark-
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ably ant-like in their earlier stages. During the year 1900, when I was living in St. Mary's Road, Oxford, there was in the garden a rather old, diseased apple-tree, badly infested with cotton-blight, Sesiids, Aphides, etc. Ants of the species *Lasius niger*, L., were always journeying up and down the trunk, and in their company were many individuals of an immature Capsid bug, which Mr. E. A. Butler identifies as a species of *Pilophorus*, probably *P. cinnamopterus*, Kb. At this stage the bugs were remarkably ant-like, and there can be little doubt that this mimetic resemblance as well as the companionship of the ants is advantageous to them.

"*Nabis lativentris*, Boh.—At Wellington College, Berks, on Aug. 10th, 1907, I found an immature example of the Reduviid bug, *Nabis lativentris*, Boh., actually in the ant-run and in company with *Lasius fuliginosus*, Latr. Again at Bembridge, Isle of Wight, on July 8th, 1909, another immature specimen of the same species was found in company with *Lasius niger*. It is well known that these immature bugs possess a large, whitish patch on each side of the first abdominal segment, obliterating its breadth and giving it the appearance of a narrow, ant-like waist. This species, like the preceding, no doubt derives benefit from its close resemblance to ants and association with them.

"I wish to thank Mr. E. A. Butler for kindly determining this species for me. The examples now exhibited I have given to the Hope Department, where they will be accessible to all students of insects."

Mr. Donisthorpe observed that he had already made and published the same observations on the same species, with the exception of the Pompilid, and that it was very interesting that Mr. Hamm should have independently recorded the same circumstances. The President observed that in countries which might be called the headquarters of the Pompilids, and where they were divided into three groups, so far as colouring is concerned, *viz.* black, yellow and black, and red and black, he had frequently noticed that each group was accompanied by other insects of various orders, of the same coloration in each case. He suggested that the question of mimicry involved in the cases under discussion has a much wider scope than any to which British insects alone can supply an answer.

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Family containing a new Female form, leighi, bred from a trophonius, Westw., Female of Papilio dardanus cenea, Stoll, from Pinetown, Natal.

Prof. Poulton exhibited the *trophonius* parent and the fifty-five offspring reared from her eggs by Mr. G. F. Leigh, F.E.S., of Durban. This very interesting family had been accompanied by the following notes written by Mr. Leigh:—

"*Durban,*
"*Sept. 24th,* 1910.

"I should have sent you this brood of *cenea* last mail, but I was away from Durban. I feel certain you will be very pleased with it, as it is certainly the most extraordinary lot I have ever reared from ova, and includes all three forms of the ♀ and also two specimens of another very fine variety. I am sending all to you, including these two varieties. This brood has taken up a great deal of time, and I have bestowed the greatest care upon them all through—about eleven weeks in all. I think the result will prove this, as I have only had seven deaths, and only one real cripple in the whole lot.

"As usual when breeding a number of specimens there is

a greater proportion of females. There were great differences in the duration of the larval stage, some individuals feeding up very quickly, and others slowly, and also taking longer to change their skin and to pupate. I am certain that this also happens in wild larvae. The duration of the pupal state, however, varied very little. The first eight specimens bred took as nearly as possible two months from ovum to imago. At this time of the year I am sure the complete cycle would not exceed six weeks, but the parent of this brood was captured in our mid-winter (dry season), and consequently the food-plant was very dried up until the rains of about the last four days. This, in my opinion, accounts for the fact that the larvae did not feed so freely as they would have done at this time of the year.

"I think this is a very interesting brood, and the results undoubtedly show that the *hippocoon* form is the rarest of the three female forms here, and this is really as it ought to be, for *Amauris dominicanus* which it mimics is very scarce now.

Quite independently of this family, all collectors here now find the *hippocoon* form is getting rarer in the wild state, while *trophonius* is not so scarce. The very fine varieties, Nos. 36 and 48, with a pattern including elements from all the three other forms must now certainly rank as another distinct female form, for I have bred two others this year. One of these is in the Transvaal Government Museum, Pretoria, and the other Mr. A. D. Millar received in exchange. Mr. Millar also captured a damaged specimen in his own grounds, and another has been taken by Mr. Haygarth.

"Most of the females in this lot seem to me to be rather browner than usual on the underside. You will notice that two of the *trophonius* forms resemble the parent in possessing the brown suffusion of the white subapical bar of the fore-wing.* One *cenea* is a nice variety with one of the spots on the fore-wing brown instead of white.† All the specimens, with two or three exceptions, are larger than any I have bred

* Careful examination of the set specimens reveals this character in all the four *trophonius* offspring, see p. xxxviii.—E. B. P.

† This character is also present in other specimens, see pp. xxxvii, xxxviii.—E. B. P.

from ova before, owing no doubt to the larvae being sleeved in the early stages on the living food-plant. I shall always adopt this method in future. The parent of this family was captured at Pinetown, Natal, and it is interesting that the two specimens similar to Nos. 36 and 48 that I bred early in the year, were also reared from Pinetown larvae.

"G. F. LEIGH."

Later in the year 1910 Mr. Leigh succeeded in breeding two more examples of the new *leighi* form of female, as stated in the following extracts from letters received from him :—

"*Durban*,
"*Nov.* 26*th*, 1910.

"I have bred one more of the fine variety of *P. cenea* ♀ similar to the two sent you. This one, curiously enough, is also from the ova of a *trophonius* ♀, so all five here bred are from that form of parent.

"I have bred in all about 250 *P. dardanus cenea* from different parents: obtaining only 8 *hippocoon* form of the ♀, about 14 *trophonius* and 120 *cenea*, the others being males."

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"*Durban*,
"*Dec.* 10*th*, 1910.

"This form seems now likely to establish itself in this part of the country, as I have bred another one from a wild larva found at Sydenham, about three miles from here. It was a very large, splendid specimen.

"G. F. LEIGH."

The female parent of the family exhibited was captured by Mr. Leigh on June 26, 1910, at Pinetown, Natal (about 1000 ft.). She laid sixty-two eggs on June 27th–28th. The parent is a typical *trophonius* with a slight fulvous suffusion in the costal section and also along vein 5 of the subapical bar of the fore-wing, and without an apical spot. The spot within the fore-wing cell is divided, the detached outer end being greyish and obscurely defined. The large costal part of the marking is rather broad and short, in the form of an isosceles triangle with its base towards the costa. Hereditary influence is clearly manifest among the offspring, in the

frequency with which the spot is divided, and less frequently in the appearance of the detached end and the form of the costal section.

The offspring, consisting of 25 males, 22 *cenea* females, 4 *trophonius* females, 2 *hippocoon* females, and 2 *leighi* females, emerged in the order and pupated on the dates shown in the following table :—

Offspring of *trophonius* female of *Papilio dardanus cenea* captured June 26, 1910, at Pinetown, Natal.

No.	Date of Pupation (1910).	Date of Emergence (1910).	Sex and ♀ form.
1	August 13	August 26	*Cenea* ♀
2	,, 14	,, 26	*Cenea* ♀
3	,, 14	,, 27	Male
4	,, 15	,, 27	Male
5	,, 15	,, 28	Male
6	,, 16	,, 28	*Cenea* ♀
7	,, 16	,, 28	Male
8	,, 17	,, 28	Male
9	,, 15	,, 29	*Cenea* ♀
10	August 16	August 29	*Cenea* ♀
11	,, 16	,, 30	*Trophonius* ♀
12	,, 17	,, 30	Male
13	,, 17	,, 30	*Hippocoon* ♀
14	,, 17	,, 30	*Cenea* ♀
15	,, 18	,, 30	*Cenea* ♀
16	,, 19	,, 31	*Hippocoon* ♀
17	,, 19	September 1	*Cenea* ♀
18	,, 20	,, 2	Male
19	,, 20	,, 2	*Trophonius* ♀
20	,, 20	,, 3	Male
21	,, 21	,, 4	Male
22	,, 21	,, 4	*Cenea* ♀
23	,, 21	,, 4	*Cenea* ♀
24	,, 22	,, 4	Male
25	,, 22	,, 4	*Cenea* ♀
26	,, 23	,, 5	Male
27	,, 23	,, 5	*Cenea* ♀
28	,, 24	,, 5	Male
29	,, 24	,, 5	Male
30	,, 24	,, 6	Male
31	,, 24	,, 6	Male
32	,, 24	,, 6	Male
33	,, 24	,, 6	*Trophonius* ♀
34	,, 24	,, 6	*Trophonius* ♀
35	,, 25	,, 6	Male

No.	Date of Pupation (1910).	Date of Emergence (1910).	Sex and ♀ form.
36	,, 25	,, 6	*Leighi* ♀
37	,, 26	,, 7	Male
38	,, 26	,, 7	Male
39	,, 26	,, 7	Male
40	,, 26	,, 7	*Cenea* ♀
41	,, 26	,, 7	*Cenea* ♀
42	,, 26	,, 7	*Cenea* ♀
43	,, 27	,, 7	Male
44	,, 27	,, 7	Male
45	,, 25	,, 8	*Cenea* ♀
46	,, 26	,, 8	Male
47	,, 26	,, 8	*Cenea* ♀
48	,, 26	,, 8	*Leighi* ♀
49	,, 27	,, 8	Male
50	,, 27	,, 8	Male
51	,, 27	,, 8	*Cenea* ♀
52	,, 27	,, 8	*Cenea* ♀
53	,, 27	,, 8	*Cenea* ♀
54	,, 27	,, 8	*Cenea* ♀
55	,, 27	,, 8	*Cenea* ♀

The proportion of the female forms in this very interesting family most nearly approaches that of Family 4, bred in 1906 from a *hippocoon* parent (Trans. Ent. Soc., 1908, p. 429). The present family contains, however, nearly three times as many

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cenea (22 to 8), and, above all, the two remarkable *leighi* forms. In the numbers of *trophonius*, 4 as against 3, and of *hippocoon*, 2 as against 3, there is a close resemblance between the two families.

The 25 male offspring exhibit the transition usually found in Natal between a somewhat heavily marked submarginal band to the hind-wing and one in which the costal and inner gaps are clearly indicated. The series is a normal one with nothing remarkable about either of the extremes.

Several of the *cenea* offspring exhibit the influence of the *trophonius* parent in the richer deeper tinge of the basal patch of the hind-wing—an effect which is particularly distinct in Nos. 17, 6, 14, 1, 45, and 53, increasing in the order of these numbers. A similar influence of the *trophonius* parent upon the *cenea* offspring was observed in 1906 (Trans. Ent. Soc., Plate XVII, fig. 8, and Description, p. 313) and of *hippocoon* upon *cenea* in 1908 (Trans. Ent. Soc., p. 436).

This parental influence upon the tint of offspring belonging to a different form is extremely interesting, especially when, as in most cases, no other visible effect is produced.

In describing the spots of the fore-wing the terminology suggested in Trans. Ent. Soc., 1908, p. 433, is followed. The submarginal spots (α) (β) and (γ) are normal in 15 specimens. (α) is so minute as to be nearly invisible in 23 and 41: it is wanting and (β) minute in 40 and 47: both are wanting and (γ) minute in 1 and 54. The missing spots are present on the under surface of all these specimens. The apical spot (δ) is wanting from both surfaces of 1, 45, and 53.

All the spots of the fore-wing upper surface are white in 6, 15, 23, and 47, and in 17, 22, 27, and 42 except for a faint yellowish tinge of the inner marginal border of the principal spot (1). In speaking of "spots" I do not include the streak along the inner margin (in 15, 27, 42, 51, 55, and minute traces in a few others), or the extension downwards and outwards from spot (1) into interspace 1*b* (in 23, 27, 41, the right side of 15, and slight indications in several others). The above-mentioned markings where present in this family are invariably ochreous. (1) is darkest

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ochreous in 1 and 9 in which the other spots are pale yellowish, the tint being most distinct in spot (3). In the 12 remaining specimens (1) is pale yellowish and the other spots white except (3) and more rarely (5) which in some specimens are *very faintly* tinged with yellow.

Spot (2*a*) between (2) and (3) is present and of large size in 15, 23, and 42, minute in 6, 17, 27, 25 and 45, minute and only on the left side of 41. It is present on the under surface of all these and a few others. A new spot (3*a*) not hitherto described is placed in the angle between veins 7 and 8, where they diverge from each other, in 9 and 45. A minute spot (4*a*) is present in a single specimen 52.

Spot (5) within the cell is divided into two in the usual manner in about half the specimens of *cenea*: it is small in a few and minute in 54.

The 22 *cenea* offspring are thus a very interesting set,

tending on the whole, as in Natal specimens generally, to resemble the *Amauris albimaculata* and the white-spotted forms of *A. echeria.* The appearance of the same peculiarity, such as the division of spot (5) in many individuals supports the evidence brought forward in 1908 (Trans. Ent. Soc., pp. 443–5) that modifications of minute elements in the pattern are certainly hereditary.

Of the 2 *hippocoon* offspring, No 16 possesses the apical spot (8) of the fore-wing, while No. 13 resembles the parent in being without it. Spot (5) in both resembles the parent, but not so completely as that of the 4 *trophonius.*

Of the 4 *trophonius* offspring, two, Nos. 33 and 34, possess the apical spot, while Nos. 11 and 19 are without it. All four exhibit the faint fulvous suffusion of the costal section of the subapical bar—a condition more strongly developed in No. 33 than in the parent.

Papilio dardanus, new female form *leighi.*

There can be no doubt that this variety, bred in Natal by Mr. Leigh six times in 1910 and also captured twice in Natal, possesses sufficient stability to rank as one of the female forms of *dardanus.* I therefore propose to name it the *leighi* form in honour of the naturalist who was the first to breed *P. dardanus,*

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the most interesting of butterflies, from known parents. Further convincing evidence of its stability as a form is seen in the fact that it also occurs almost unchanged so far away from Natal as the N.E. corner of the Victoria Nyanza. A specimen collected by Mr. A. H. Harrison about 1903 at "Unyori," N.E. of Kisumu, differs from the Natal specimens no more than the other female forms of *P. dardanus* from these two remote localities are known to differ. "Unyori," as Mr. C. A. Wiggins informs me, is certainly a rendering of "Nyangori," a forested locality at a height of about 5000 ft. to the N.E. of the great lake. Mr. Harrison's specimen was figured $\frac{7}{8}$ of the natural size, by the present writer in Trans. Ent. Soc., 1906, Plate XX, fig. 1. It is there spoken of as "intermediate between *planemoides* and *cenea.*" The figure here referred to may stand as an adequate repre-

sentation of the *leighi* form described below, the slight differences between it and the Natal specimens, as also between the two latter, being indicated in the description.

Fore-wing upper surface. All the markings possess a rich fulvous tint closely resembling that of *planemoides*, becoming paler in closest proximity to the costa in the two Natal specimens. The three paler markings are: spot (4), between veins 8 and 9, the costal end of spot 5, within the cell, and the apical spot (δ), between veins 7 and 8. This increasing paleness towards the costa is also often seen in *planemoides*. In form and position the subapical bar is that of *trophonius* and *hippocoon*, while the other markings are those of *cenea*. In this latter form, the principal spot (between veins 2 and 3) may be extended downwards and outwards into the next interspace between veins 2 and 1), as may be seen in the examples represented on Plate XXVI, figs. 18, 19, and 21, of Trans. Ent. Soc., 1908. In the *leighi* form the same tendency is manifested to an equal extent in specimen 48, to a slightly greater extent in 36. The latter furthermore possesses the linear marking along the inner margin which is also often seen in *cenea*; e.g. in the original of Fig. 18 referred to above. In the Unyori (Nyangori) example (Plate XX, fig. 1, Trans. Ent. Soc., 1906) the principal spot extends downwards much further and is continuous with the linear

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marking. In this latter example the subapical bar is also more fully developed and a faint extension of it intrudes into the space between veins 3 and 4 and a still fainter extension between 3 and 2, thus tending to bridge over the interval between the bar and the principal spot. The Unyori specimen in fact differs from the two Natal specimens in its slightly nearer approach to the pattern of *planemoides*.

Hind-wing upper surface. The submarginal spots, resembling those of *planemoides*, are fulvous, becoming pale towards the costal end of the series. The paleness begins in the pair of spots in interspace 5, while those in 6 and 7 are nearly white. This increasing paleness is far less marked in the Unyori specimen. In form and size the great basal patch resembles that of *cenea* and is somewhat smaller than in *planemoides*.

In 48 it is sharply demarcated from the black ground-colour, while in 36 a more gradual transition is afforded by a sprinkling of dark scales. The latter condition exists in the Unyori specimen, and both are common in *cenea*. The colour of the patch in 48 and in the Unyori example resembles that of a rather deeply-tinted *cenea*, the Unyori example differing, however, in its duller shade. The patch of 36 exhibits an approach to the whiteness of *planemoides* in its pale yellow tint, which contrasts sharply with the rich colour of the other markings.

Both Natal specimens possess the intense black ground-colour and comparatively short fore-wings of the Natal *cenea*, while the Unyori specimen possesses slightly longer fore-wings and the duller fuscous tint of *planemoides*.

The under surface of both wings. The pattern of the under surface closely resembles that of the upper, as in both *cenea* and *planemoides*. The chief difference, in both these forms, is due to the duller, browner shade of the black ground-colour of the parts exposed in the resting position. Many of the markings also tend to spread and to become less sharply demarcated. The general effect of these changes in background and markings is that the whole of the exposed pattern looks obscure and dull as compared with the upper surface. There is a clear indication of the "costal gap" (Trans. Ent. Soc., 1904, p. 683) on the under surface of 36, the pale colour

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of the basal patch streaming outwards in the 5th interspace (between veins 5 and 6). This feature, also commonly found in *cenea*, *planemoides* and other forms, is very faintly indicated in 48, and barely visible in the Unyori example.

I select as the type specimen 48 in the Hope Department, Oxford University Museum, choosing it rather than 36, because of the deeper tint of the hind-wing patch. This tint is also found in the Unyori specimen, and is probably more typical of the *leighi* form than the much paler shade of 36.

In addition to the individual differences between these three specimens described above it may be added that the spot in the cell is undivided in 36, but divided in the other two, the detached extremity being nearly obsolete in the Unyori

(Nyangori) example. The submarginal spot (a) is wanting from 48 (although present on the under surface), but not from either of the other specimens. The apical spot (δ) is well developed in all.

The *planemoides* form is entirely unknown in Natal, and indeed in areas far to the north of it, and hence it is impossible to adopt the plausible interpretation of *leighi* as a hybrid between *cenea* and a male bearing the *planemoides* tendency, or *vice versa.* We are therefore driven to the hypothesis that the *leighi* form is a persistent definite stage in the evolution of *planemoides.*

My friend Mr. Roland Trimen, F.R.S., has kindly sent me (August 14, 1911) the following account of three specimens in his collection which possess the *leighi* pattern, but differ in the uniform ochreous tint of all the markings :—

"As regards the curious form of ♀ *P. dardanus* you write about, which Leigh has sent from Natal, and which you say is really the same as the one you figured in Trans. Ent. Soc., 1906, Pl. XX, f. 1, from N.E. of Victoria Nyanza, I have been looking up my lot of the S. African sub-species, and find 3 examples which approximate your fig. 1. The first and second of these you will find noted in my "S. Afr. Butt.," iii, p. 249 (under "B.h." in the text), and treated there as linking *hippocoon* and *trophonius*; the St. Lucia Bay example was taken by Col. H. Tower in 1867, and the Delagoa Bay one by Mrs. Monteiro in 1883. The third was captured at Morakwen,

Delagoa Bay, by Rev. H. Junod, 22nd January, 1891. In all three the inner-marginal fore-wing patch and the hind-wing patch are larger than in your fig. 1, but vary in size. All the markings in all three are rather strongly tinged with dull ochreous-yellow. Your fig. 1 is not coloured, but you give some account of the colouring in the "Explanation" and at pp. 293–4, from which I gather that the tint of the fore-wing (but not that of the hind-wing) markings is much deeper and richer, and more like that shown by *planemoides,* than any one of my three ♀ ♀ exhibits. In my specimens *all* the markings are of about the same pale 'buff' tint, with only a slight inclination to a rufous tinge.

"I can quite imagine a tendency of *planemoides* to crop up occasionally in the progeny of the S. African sub-species, notwithstanding the remoteness of the equatorial model. Indeed, something of this kind is noticeable in Cape Colony, where the *hippocoon* form is occasionally met with as far as *P. cenea* extends, although its model *Amauris dominicanus* is wholly absent."

An East African variety of the female *dardanus*, described and figured by Aurivillius as *mixtus* (Arch. f. Zool. Bd. 3, No. 23 (1907), T. 2, f. 2), presents many points of resemblance to *leighi*, but is intermediate between this form and the East African *planemoides* described below. *Mixtus* differs from *leighi* and approaches the example of *planemoides* in the greater development of the fulvous marking along the inner margin of the fore-wing, in the greater length and size of spot 5 (within the cell), and in the whiteness and the much greater size of the hind-wing patch. *Mixtus* also apparently differs in the far paler tint of the fulvous markings.

In such a protean species as *dardanus* I do not think it is convenient to give separate names to all the single varieties and transitional specimens, but in *leighi* we have a form that is not only distinguishable but possessed of sufficient stability to appear again and again over a very wide area. Furthermore, it is the only *planemoides*-like form known in Natal.

PAPILIO DARDANUS, BROWN, FEMALE FORM PLANEMOIDES, TRIM., FROM THE COAST OF BRITISH EAST AFRICA.—Prof. POULTON also exhibited an example of the *planemoides* female

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captured in August 1910, in forest country (less, and probably much less, than 100 ft. elevation) between Jilore and Malindi. Jilore is about 70 miles N. of Rabai and 19 W. of Malindi. The specimen, which was kindly presented to the Hope Department by the Rev. K. St. Aubyn Rogers, M.A., F.E.S., had been taken by a native collector. The pattern of the fore-wing closely resembles that of the specimen collected by Mr. A. Harrison at Nyangori about 1903, and represented on Plate XX, fig. 3, of Trans. Ent. Soc. for 1906. It is there described as intermediate "between *planemoides* and *hippocoon*." The exhibited specimen differs from the figure in

its approach to the pattern of *leighi*, the spot within the cell (undivided) being widely separated from the subapical bar and the latter only connected with the greatly enlarged principal spot (1) by scattered fulvous scales between veins 3 and 4. Below vein 3 the pattern almost precisely reproduces the appearance represented in Fig. 3, above referred to, the *hippocoon*- and *trophonius*-like extension of the pale pattern along the inner margin towards the base of the wing being slightly more evident in the coast specimen. The hind-wing is also *hippocoon*-like in the great size of the white patch, which is far larger than in normal specimens of *planemoides*.

The occurrence of *planemoides* on the E. coast, so far from its *Planema* models, is of high interest, as also is the fact that this, the only specimen hitherto recorded from the area in question, should not be a typical example but one exhibiting several ancestral features.

The specimen may be compared with another very interesting example, captured Sept. 22, 1901, in forest country about ten miles inland from Mombasa, near Changamwe, by Mr. C. A. Wiggins, F.E.S. While the pattern is almost precisely as in the exhibited specimen, the colouring is that of *trophonius*, or rather of its modification *niobe*, Auriv.; for the subapical bar of the fore-wing is fulvous like the other markings. The specimen also lacks the scattered scales connecting the bar with spot (1). The increasing lightness of the markings towards the costa of the fore-wing, spoken of on p. xxxix, is well marked. Except for this change the fulvous colouring is of a uniform pale shade like that of the

trophonius (and *niobe*) of *P. dardanus tibullus* and *dardanus dardanus*—a shade very different from the richer, deeper fulvous of *planemoides*.

HEREDITY IN THE FEMALE FORMS OF HYPOLIMNAS MISIPPUS.—Professor POULTON exhibited a series of thirty-five females of the type form, together with their female parent, of the *inaria* form, captured Aug. 15, 1910, by Rev. K. St. Aubyn Rogers, M.A., F.E.S., at Rabai, near Mombasa. The males were liberated and the females emerged from the pupa on the following dates:—

Sept. 15, 1910—sixteen, 4 with a slight, 2 with a rather more pronounced white patch on the hind-wing; Sept. 16—nine, 1 with slight, 2 with more pronounced white patch; Sept. 17—eight, 5 with slight indication of the patch; Sept. 18—two, 1 with slight indication of patch.

The female parent is a typical *inaria*, with no indication of the white patch on its hind-wing. The female offspring were all typical *misippus*.

This result compares in a most interesting manner with those obtained on two other occasions. The first of these is the family of fifty *inaria* females bred in 1908 by Mr. Rogers from an intermediate female parent, also from Rabai (Proc. Ent. Soc., 1909, pp. xxxvi, xxxvii). This latter parent was "intermediate between the type and the *inaria* form, but on the whole nearer the former . . . the whole of the female offspring were *inaria*—not a single type form, not a single intermediate." The second is the family bred in 1904 by Mr. G. F. Leigh, F.E.S., from an intermediate female captured in the Durban district. Of the eight female offspring four were typical *misippus*, three typical *inaria*, and one intermediate (Trans. Ent. Soc., 1904, pp. 689, 690, Plate XXXII).

Thus there have been bred from *inaria* or intermediate females, first, equality of *inaria* (including intermediate) and *misippus*; secondly, *inaria* alone; thirdly, *misippus* alone. These results are consistent with the Mendelian relationship, if we assume (1) that the intermediate female behaves in heredity like *inaria*, (2) that *misippus* is dominant over *inaria*, (3) that the first male parent was a heterozygote, the second carried the tendency of *inaria*, the third that of *misippus*.

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Euralia anthedon, Doubl., and E. dubia, Beauv., proved by breeding to be the forms of a single species.—Prof. Poulton exhibited a female parent of the *dubia* form captured on March 19, 1911, at Oni, 70 miles E. of Lagos, by Mr. W. A. Lamborn, together with a selection from the offspring reared from its ova. The offspring included both *dubia* and *anthedon*. Thus Mr. Lamborn had been able to verify the suggestion made in Trans. Ent. Soc., 1902, p. 492: "If Mr. Marshall's conclusion [advanced, on pp. 491–2, that the

Eastern Euralias, *wahlbergi*, Wallgr., and *mima*, Trim., are the forms of a single species] be established, it follows that the corresponding and closely-allied mimetic West African forms *Euralia anthedon* and *E. dubia*, connected like *wahlbergi* and *mima* by intermediate varieties, are similarly the dimorphic forms of a single species." Mr. Marshall's conclusion concerning the Eastern species was confirmed by the late Mr. A. D. Millar in 1909 (Trans. Ent. Soc., 1910, p. 498), and the further prediction about the Western species is now, in 1911, verified by Mr. W. A. Lamborn. The Western problem is, however, the more complicated and interesting of the two; for *Euralia dubia* is not a simple mimetic form like *mima*, but is itself modified in the Oni district into three subordinate forms, in mimicry of (1) *Amauris egialea*, Cram., with much yellow in the hind-wings, (2) the most strongly white-marked of the local forms of *Amauris psyttalea*, Plötz, (3) *Amauris hecate*, Butl., and the darkest forms of *A. psyttalea* which closely resemble them. The hereditary influence of the parent *dubia* upon its *dubia* offspring was clearly evident in Mr. Lamborn's families.

[It may be added that Mr. Lamborn has now bred families from three *dubia* parents of various forms, and one from an *anthedon* parent, all captured at Oni in March of the present year. Both *anthedon* and *dubia* appeared in all the families. The numbers of the offspring are very large, and the two forms always bear a simple numerical relationship to each other, such as we should expect to see in a Mendelian pair. At the date of the meeting (June 7) only two of these families, both from *dubia* parents, had arrived in this country.—E. B. P., Aug. 7, 1911.]

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Instances of Mimicry, Protective Resemblance, &c., from the Lagos District.—Mr. W. A. Lamborn, who was introduced by Prof. Poulton, had intended to show at this meeting the cases which he had exhibited at the Conversazione, but owing to a misunderstanding, they had not arrived. He made, however, the following observations:—

"Prof. Poulton's account of the mimicry of certain Danaine butterflies by Euralias induces me to mention that I recently

took at one sweep of my net two butterflies, an *Amauris psyttalea*, Plötz, and a *Euralia dubia*, which were flying round and round each other in a manner suggestive of courtship. Their movements on the wing were so active that I was unable to recognise them before capture, and it seemed to me evident that the one must have been deceived by the mimetic resemblance to its own species exhibited by the other.

"In the exhibit which I had hoped to bring to your notice is a West African Hypsid moth determined by Prof. Poulton as *Deilemera*, probably *antinorii*, Oberth., with the cocoon from which it emerged. The cocoon bears a large number of creamy white semi-transparent frothy spheres which bear a very strong resemblance to the cocoons of Braconid parasites. The cocoon was formed during the night by a larva in my possession, and it bore these structures when I first saw it. Their resemblance to the cocoons of the parasites was so marked that I did not make a very careful examination, and I did not discover their spuriousness till the moth came out. Prof. Poulton has since pointed out that the structures are very loosely heaped up on the cocoon, and that they are also noticeable on the silky material in the immediate neighbourhood of the cocoon, facts which tend to suggest still more strongly that the structures are Braconid cocoons. They doubtless have a protective function. A bird, for instance, would soon learn that a cocoon bearing the Braconid cocoons does not contain a pupa worth eating, and it is reasonable to suppose that it would likewise pass by a cocoon bearing structures which resemble them in such a remarkable way.

"I have obtained some light on the relationship between the 'brands' or patches of peculiar scales on the wings of male *Danainae* and the double tuft of hairs which can be

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protruded from the posterior extremity of the body. In January of this year I observed a male *Amauris niavius*, L., settle on the upper surface of a leaf with its wings expanded. The insect flexed its abdomen, making the dorsal surface convex, so that the extremity of the body was brought level with the brands, and the tufts were then thrust out. By alternately flexing and straightening out the abdomen the

tufts were passed to and fro over the surface of the brands as though some secretion was being conveyed from the one to the other. Prof. Poulton has suggested that the greasy appearance of the brands may be probably interpreted on the hypothesis that they serve to retain and distribute a scent employed in courtship brought to them by the tufts."

Dr. LONGSTAFF said that he was satisfied that in *Euploea* and *Danaida chrysippus* the characteristic scent was not caused by the tufts and brands, though these were very likely the cause of another volatile scent which certainly existed in these cases. Female Danaids have a scent as well as males; the scent common to both being nauseous, while that peculiar to the male is probably a help in courtship.

Prof. POULTON remarked that the brands actually are greasy, and not merely look so, and that they may for a time hold the scent transferred to them by the tufts.

Dr. JORDAN observed that the discovery in Natal of intermediates between *cenea* and *planemoides*, which from previous experience had been supposed not to exist, made it impossible any longer to argue from their non-existence in favour of the sudden, as opposed to the gradual, evolution of dimorphic forms.

Wednesday, October 4th, 1911. [liii

SEPARATION OF THE SEXES IN HYPOLIMNAS MISIPPUS.—Dr. F. A. DIXEY read a letter received by him from Mr. E. A. AGAR, of Dominica, West Indies, on the subject of the Separation of the Sexes of *Hypolimnas misippus*, in which the writer remarked that in that island, although haunting similar localities, the ♀ remains on the coast while the ♂ is to be met with some distance inland. The former is scarcely ever to be seen in company with the ♂ of its own species, though it flies with *Danaida plexippus*, of which it is a mimic. Mr. Agar suggested that it looked as if "both sexes were aware that if they flew in close association it would give the show away," which implies intelligence of too high an order.

Dr. DIXEY remarked that it was a common experience that

one sex of a butterfly at any given time was more in evidence than the other. Of course, in such cases it was certain that the other sex must be somewhere. Mr. Millar, of Durban, had drawn his attention to the fact that, speaking generally, the males were more apt to be on the wing during the morning, and the females in the later hours of the day. Mr. A. R. Wallace mentions that the males and females of certain South American Pierines, of which the males are practically ordinary white butterflies and the females are Ithomiine mimics, have different habits and do not fly together. The females accompany their models in flight, which suggests the significance of the habit. The fact that some means of protection required the adoption of a corresponding habit to make them effective, of course did not carry with it any assumption of consciousness on the part of the insect of the
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significance of its behaviour. The habit was of the nature of a reaction or response, which, like other adaptations, had grown up under the influence of natural selection.

Dr. LONGSTAFF observed that in North Africa certain species of *Teracolus* gave abundance of ♂♂ in the morning, whilst in the afternoon the ♀♀ predominated greatly.

Commander WALKER, Mr. G. A. K. MARSHALL and Prof. POULTON also took part in the discussion.

THE COCOON OF DEILEMERA ANTINORII, OBERTH.—Prof. POULTON exhibited the cocoon of the Hypsid moth *Deilemera antinorii*, Oberth., which Mr. W. A. LAMBORN described (*see* p. xlvi), and had intended to exhibit on June 7 last. He stated that Mr. Lamborn had written on September 4, since his return to the Lagos district: "The larva passes the cocoon-like bodies through the anus, as you surmised." A little later, on September 10, Mr. Lamborn had written: "I cannot add more precise information as to the way in which the cocoons are formed, for the larvae which have hitherto spun up, did so at a time when I could not conveniently observe them. I saw, however, a few more of the Braconid-cocoon-like bodies passed *per anum* at the end of the cocoon opposite that at which the larva was spinning, and when several had accumulated the larva turned round and distributed them."

All-female Batches of Acraea encedon, L., bred in the Lagos District.—Prof. Poulton also exhibited examples from three of the all-female broods obtained by Mr. W. A. Lamborn, viz. from Companies 2 and 3 and from Family 1 in the table printed below. These three sets were chosen because they prove that the unisexual batches are not necessarily associated with either of the forms of *encedon* in the locality. Thus Family 1 was all *lycia*, Company 3 all *encedon*, while Company 2 was as nearly as possible half and half (23 to 24). The table clearly shows, in a condensed form, all the results hitherto obtained in this species by Mr. Lamborn. Out of the three families, one was all-female; out of the seven companies, three. Furthermore, the results obtained from the two sets of wild larvae strongly suggest that both were, in chief part, composed of the scattered individuals of an all-female batch, intermixed, in the June-July series, with an

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earlier bisexual brood, in the December series with a later one.

1910	*Encedon*		*Lycia*		History
	♂	♀	♂	♀	
Company 1			46	32	From batch of eggs on single leaf
,, 2		24		23	,, ,, ,,
,, 3		35			,, ,, ,,
,, 4	6	2	4	1	,, ,, ,,
,, 5		6		16	,, ,, ,,
,, 6			3	3	,, ,, ,,
,, 7	2	1	7	6	,, ,, ,,
Family 1				48	From ♂ and ♀ *lycia* captured in cop.
,, 2			19	13	From ♂ and ♀ *lycia* of Company 4
,, 3	5	11	6	13	From a captured ♀ *encedon*
Wild Larvae	6	8	5	26	Emerged June 26–July 13, 1910. Only females appeared after July 7: 3 *encedon* and 24 *lycia*
,, ,,		17	3	18	Emerged December 10–24, 1910. The 3 males appeared with 2 ♀ *lycia*, December 23–4

It is to be noted that the three all-female companies were bred from eggs laid normally in the wild state, and the con-

clusion is inevitable that a large proportion of such companies is the normal occurrence. On the other hand, the figures suggest that all-male companies are not normally produced. Males, however, were more numerous than females in all the bisexual batches except Company 6 and Family 3; and the males often emerged earlier than the females. The common occurrence of the unisexual companies obviously promotes interbreeding, and the advantages of interbreeding, acting as selective criteria, may have increased the tendency to produce nothing but females as soon as it appeared.

These results have been submitted to Mr. L. Doncaster, who agrees with Prof. Poulton in thinking it probable that the *lycia* form, although far commoner in the district, is recessive. Mr. Doncaster wrote, September 26: "On the data available I am inclined to think *encedon* is dominant. The Family 2 from parents ex Company 4 is hardly explicable on any other view, and, as you say, the existence of several pure *lycia* broods
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suggests it strongly. The arguments for the dominance of *lycia* appear to be the brood from Company 7 (but out of a total of sixteen it is not very unusual to get such departures from the expected 1 : 1 ratio), and the fact that *lycia* is the common form in the locality. This, however, is not of great weight."

Mr. Doncaster has suggested, and Prof. Poulton has forwarded to Mr. Lamborn the lines of future experiments, which it is hoped will throw more light on the Mendelian relationships, and, above all, on the unisexual broods of this interesting *Acraea*.

THE PROOF BY BREEDING THAT ACRAEA AURIVILLII, STAUD., IS THE FEMALE OF A. ALCIOPE, HEW.—Prof. POULTON exhibited a series of eight *A. alciope* and five *A. aurivillii* bred in the present year by Dr. G. D. H. Carpenter from thirteen small larvae found on a single leaf of the food-plant on Damba Island, in the Victoria Nyanza to the east of Entebbe. The result entirely confirmed the conclusions of Mr. Eltringham and Dr. Jordan, as published in the Proceedings for November 17, 1909 (pp. lxvii–lxix).

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Insects seeking High Ground.—The President said that about the beginning of July this year, he had noticed, while collecting near El Guerrah, the junction for Constantine, Biskra and Alger, both sexes of the yellow and black *Leucospis gigas*, and of another red and black *Leucospis*, flying in great numbers, with a loud humming noise, round a cairn of stones on the top of a hill, and suggested that the common instinct to seek high places might provide a meeting-ground for the sexes. He had been surprised to find these insects together in such numbers, as, being parasitic on different species, they would be likely to be separated.

Prof. Poulton referred to his communication "A possible explanation of insect swarms on mountain tops" (Proc. Ent. Soc. 1904, p. xxiv.), and suggested that the instinct referred to by the President would probably be especially useful in the case of parasitic insects whose hosts might naturally be separated, as some means of providing a meeting-place would be particularly necessary.

Wednesday, October 18th, 1911. [lix

Exhibitions.

Papilio (Tachyris) melania, Fabr.—Dr. F. A. Dixey exhibited a pair of each of the following species—*Tachyris melania*, Fabr., *T. celestina* and *Catophaga ega*, Boisd., and remarked upon them as follows:—

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"*Papilio melania* was described by Fabricius in 1775, and figured by Donovan (Ins. N. Holl., 1805). Much doubt has prevailed as to the identification of Fabricius's species. Boisduval's *P. melania*, according to A. R. Wallace, is the female of *Catophaga ega*, Boisd. Wallace himself said, in 1867, 'The *Papilio melania* of Fabricius has not yet been properly identified, and probably never will be.' He was no doubt unaware that Fabricius's type was preserved in the Banksian Cabinet, where it may still be seen.

"In 1884, Miskin applied the name *T. melania* to the female

of *Tachyris celestina*, Boisd. Until quite recently the British Museum possessed no specimens of Fabricius's insect, except the type (which was not included in the general Collection). The specimens that appeared in the Collection as *C. melania* were *Pieris* (*Catophaga*) *zoe* of Vollenhoven, the Batchian form of *C. jacquinotii*, Luc. Meanwhile, the true *P. melania* of Fabricius had been re-described by Miskin in 1888 as *Tachyris asteria*.

"Mr. G. A. Waterhouse has now sent home specimens which are undoubtedly of the species described by Fabricius and represented by Donovan. It is said by Mr. Waterhouse to be rare and no doubt very local. Four of these specimens are in the British Museum, and a pair, male and female, here exhibited, have been presented to the Hope Department. These were captured at Kuranda, near Cairns, in North Queensland. Fabricius's type is in bad condition, but there can be no possible doubt that Mr. Waterhouse's specimens have been correctly identified.

"Now that the true *melania* has at last come to light it is seen to be not a *Catophaga* allied to *ega* or *paulina*, but a *Tachyris* belonging to the group which contains *T. celestina* and *T. nero*. It is a peculiarly handsome and distinctively marked butterfly; and it is probable that only its presumable rarity, and the battered condition of the type specimen, have permitted the erroneous identifications which have been current for so many years."

Wednesday, November 1st, 1911. [lxv

African Species of Acraea.—Mr. H. Eltringham exhibited specimens of African Acraeas, to show that wide differences of colour and pattern may occur in a single species, and conversely, that certain species which can scarcely be distinguished by their outward appearance are nevertheless very distinct, as shown by the structure of the male armature. Thus *A. astrigera*, Butl., from E. Africa merges gradually into the same author's *A. pseudolycia*, through an intermediate form named f. *brunnea*. *A. astrigera* is a brilliant orange-and-scarlet form, whilst *pseudolycia* is black-and-white.

In the same way *A. humilis*, Sharpe, was found to be specifically identical with *A. orestia*, Hew. The exhibitor remarked that he had been pleased to learn only that morning that his conclusions in regard to the latter species had just been confirmed by breeding, details of which he hoped to be able to publish on a future occasion. Mr. Eltringham further showed examples of *A. chambezi*, Neave, and *A. mansya*, Eltr.
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These species could only be distinguished at sight by a difference in the position of one of the hind-wing spots, but the male armature showed differences of structure which were as great as those distinguishing any other species of African *Acraea*.

Several new species and forms were also shown, including *A. lofua*, Eltr., ♂ and ♀, *A. grosvenori*, Eltr., ♂, *A. aureola*, Eltr., ♂, *A. ella*, Eltr., ♂, *A. cinerea* subsp., *alberta*, Eltr., ♂, *A. periphanes* f. *acritoides*, Eltr., ♂, and *A. astrigera* f. *brunnea*, Eltr., ♂ and ♀.

Dr. JORDAN remarked on the extreme variability of the genus and its allies, geographically, individually, and even in the characters of the genitalia.

Mr. BETHUNE-BAKER remarked on the unreliability of the genitalia in certain *Lycaenidae*.

The PRESIDENT stated that the ♂ genitalia were, as a rule, reliable in the Aculeata, but in the *Tenthredinidae* the ♂ genitalia were quite useless for specific determination, though the ♀ ♀ afford excellent characters.

The Hon. WALTER ROTHSCHILD remarked on the identity of the ♂ genitalia in certain distinct species of *Macroglossinae*. [lxix

Paper.

"A Monograph of the genus *Acraea*," by H. ELTRINGHAM M.A., F.Z.S.

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lxxii] Wednesday, November 15th, 1911.

AN "IMITATION" LARVA.—Mr. J. R. LE B. TOMLIN showed a specimen which he said was not strictly an entomological exhibit, but from its curious resemblance to a caterpillar

might be of momentary interest to Fellows. It was in reality a species of West Indian oyster (*Ostrea frons*, L.) which attaches itself to twigs.

Professor Poulton remarked that both this and the Coccinellid exhibited by Mr. Sennett were probably cases of accidental resemblance.

Rhodesian Insects as Prey.—Professor E. B. Poulton exhibited the following specimens sent to him by Mr. C. F. M. Swynnerton, both of which had been captured on the outskirts (3,800 ft.) of Chirinda Forest, Gazaland, S.E. Rhodesia.

1. The female form *hippocoon* of *Papilio dardanus cenea*, Stoll, [lxxiii
rescued, September 8, 1911, by one of his native collectors from a M'lanje Bulbul (*Phyllostrephus milanjensis*). The head was wanting, and there were symmetrical injuries at the anal angle of the hind-wings similar to those so often seen in living butterflies.

2. Two wings of *Precis archesia*, Cr., ⊙, and the fragments of a Blattid, probably of the genus *Deropeltis*, taken June 25, 1911, from a spider's web. When noticed four days earlier the wings of the *Precis* were still attached to its body, and the latter had been attacked in the manner characteristic of a largish spider. The butterfly had probably sheltered in the thatch to which the web was fixed.

Instances of Mimicry exhibited by certain Sarawak Insects.—Professor Poulton also exhibited specimens sent by Mr. J. C. Moulton from Sarawak, and said that before doing so, and reading Mr. Moulton's account of them, he wished to acknowledge the kind help he had received from Mr. C. J. Gahan, who had compared several of the Coleoptera with the types, and had described one new species of *Daphisia*, and also the kind assistance rendered to him by Sir George Hampson. He then communicated the following paper by Mr. J. C. Moulton:—

"Among some recent additions to the insect collections in the Sarawak Museum, I noticed certain curious species which, by their remarkable resemblance to species belonging to very different families, afforded excellent examples illustrating the theory of mimicry. As some of these new captures prove to

be new species, and as unfortunately they add to their rarity and value by being unique specimens, I have thought it advisable to send them to England for lasting preservation in some well-known entomological museum, where they will be safe from the ravages of a tropical climate and at the same time easily available for inspection and study. With this end in view it seemed a good opportunity first to draw attention to the *meaning* of the coloration exhibited by these insects, and so I am asking my friend and former teacher, Professor Poulton, to be kind enough to exhibit the little collection on my behalf at one of the meetings of the Entomological Society before giving them a permanent place in the Hope Collection. lxxiv]

"Before proceeding further, mention must be made of an extensive memoir by Mr. R. Shelford, which appeared in the Proceedings of the Zoological Society of London for 1902 (pp. 230–284, plates xix–xxiii), on the subject of 'Mimetic Insects and Spiders from Borneo and Singapore.' As his account in a general way covers certain of the instances mentioned here, the following notes may be regarded simply as a humble supplement to that memoir.

I. Mimetic Lepidoptera.

"1. *Moth* (Fam. *Callidulidae*) mimicking a butterfly (Fam. *Hesperidae*).

"The moth in this case is *Callidula abisara*, Moore, a common day-flying species, which flies low and slowly for short distances, frequenting shady jungle paths or half sunlit patches in mountain forests. The yellow-chrome underside is undoubtedly procryptic and is not noticeable in flight, though when at rest the wings are folded perpendicularly over the head and body, and the insect becomes invisible. The upperside, it will be noticed, has a simple pattern consisting of a dark tawny-fuscous ground-colour relieved in the fore-wing by a conspicuous subapical orange bar.

"The Hesperid (*Koruthaiolos xanites*, Butl.) has exactly the same pattern on the upperside, but its underside resembles the upper, and possesses the usual dark ground-colour typical of

this section of Bornean Hesperidae. On one occasion, while collecting on Mount Matang (near Kuching), at an altitude of 2,000 ft., I watched this Hesperid flying slowly along the side of the path in front of me, stopping every few yards and then fluttering on again, and I was astonished to notice the resemblance in its flight to the moth, an example of which I had captured on the path about ten minutes before.

"The advantage of this pattern to the moth is at once evident, for with its slow flight and a pattern resembling any of the *swiftly* flying *Hesperidae* the advantage would be nil, but given a slow flight and a pattern resembling a *slow* flying Hesperid, then the advantage becomes very real. The instance may be classed under the heading of pseudaposematic mimicry,

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since the moth is very probably palatable and the Hesperid the reverse.

"Two other Hesperids, occurring in Sarawak, bear the same upperside pattern, viz. *Kerana gemmifer*, Butl., and the larger *K. armata*, Druce. Both are fairly common species, occurring in the same locality as *Koruthaiolos xanites*, and possibly present a case of synaposematic mimicry, but I do not know their flight, and so refrain from further comment.

"2. Moth (Sub-fam. *Chalcosiinae*) mimicking a butterfly (Fam. *Pieridae*). I had for some time suspected the ♀ of the Chalcosid moth *Mimeuploea* (*Pidorus*) *inclusus*, Wlk., of being a mimic of the common Pierine, *Terias hecabe*, L., but it was not till the capture of the ♀ of an interesting allied species *Chalcosia* (*Cyclosia*) *hecabe*, Jord., in May last, that I felt at all positive about it. The majority of Sarawak females of *M.* (*P.*) *inclusus*, which is common enough, have a black hind-margin to the fore-wing, the inner edge of which is moderately even, and not indented in that marked manner characteristic of the Pierine, *Terias hecabe*. Now the ♀ of *Chalcosia* (*Cyclosia*) *hecabe* has this very indentation reproduced, and possessing also a pale yellowish ground-colour, is an excellent mimic of the Pierine.* *M.* (*P.*) *inclusus*, on the other hand, exhibits only

* Both these ♀♀, together with their ♂♂, which are entirely unlike *Terias hecabe*, are figured in Seitz, *Gross-Schmett.*, x, pl. 3, d (1907).—E. B. P.

a very slight tendency towards this indentation in the black hind-marginal border. This common Chalcosid flies slowly and for short distances in open sunny places, and settles on the upperside of leaves; it is abundant, though, of course, not to be met with in anything like the numbers that may be seen of *T. hecabe* anywhere in Sarawak. It settles with fore-wings folded over the hind-wings, presenting a flat surface, so that the *hecabe*-pattern is conspicuous. For the theory of mimicry between these two species it is, of course, unfortunate that the Pierine invariably settles with wings closed and erect, nor does this Pierine, when settled, open and close its wings slowly, so that one can see the upperside pattern, as do some of the Papilios, e. g. *P. agamemnon.* But *in flight* there is no doubt that the moth is sufficiently like the Pierine to be mistaken for it. lxxvi]

"*Terias hecabe* can be seen frequently in closely packed 'flocks' of 50 to 100 individuals settled on damp spots by the side of many rivers in Sarawak, and they should form an easy prey to any bird or insect enemy; but although I have often watched them thus settled together with other larger brilliant yellow Pierines, I have never seen them attacked; and when disturbed, instead of dispersing and flying away, they fly round and round in a thick cloud just over the same place, thus presenting an easy capture with the net.

"Various writers have noted the common occurrence of this species in the East, and certainly in Sarawak it is one of the commonest butterflies.

"Mr. Shelford mentions the resemblance of *M.* (*P.*) *inclusus* to a *Terias,* as an instance of mimicry, in his table (*l. c.,* p. 257).

II. Mimetic Coleoptera.

"1. *Between Clerids and Longicorns.*

"(*a*) The black-and-white-spotted pattern, which we notice in the Longicorn (Fam. *Lamiidae,* Sub-fam. *Phytoeciinae*), *Daphisia pulchella,* Pascoe, a beautiful mimic of the little Clerid *Callimerus bellus,* Gorham. This resemblance is described and figured in Mr. Shelford's memoir (*l. c.,* p. 247, pl. xxiii, f. 53 and

55), but it is such a beautiful example that I venture to send for exhibition the model and mimic from the same locality and taken in the same fortnight.

"(*b*) The black-and-yellow-spotted pattern, adopted by a Longicorn synaposematic association into which enters the Clerid *Callimerus mysticus*, Gorh.

"This Longicorn association is composed of

(i) The common and almost certainly highly distasteful Cerambycid, *Caloclytus annularis*, Fab. Figured by Mr. Shelford as *Chlorophorus annularis* (*l. c.*, pl. xx, f. 31).

(ii) The Lamiid (Sub-family *Phytoeciinae*) *Daphisia clytoides*, Gahan.

"This species, kindly described by Mr. C. J. Gahan in the appendix to this paper, was figured by Mr. Shelford as *Daphisia* sp. ? (pl. xx, f. 34).

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(iii) The rare Lamiid *Cylindrepomus laetus*, Pasc., var. Figured by Mr. Shelford as *Cylindrepomus* ? form of *comis*, Pasc. (pl. xx, f. 33).

"Professor Poulton has attached some interesting remarks on the far-reaching mimetic effects of this *Caloclytus*-pattern, to Mr. Shelford's account of the association (*l. c.*, pp. 250–2). It is therefore pleasant to record the entry of a member of a totally distinct family of Coleoptera into this synaposematic combination, thus affording an instructive comparison with the first Clerid-Longicorn instance given above, in which the Clerid functioned as model instead of mimic.

"2. *Between Hispids and Longicorns.*

"On a recent collecting expedition up the Limbang River in Sarawak (April 1910), we were fortunate enough to capture a little Longicorn which bore a remarkable resemblance to the spinose *Hispidae* of the genus *Dactylispa*. Dr. Chr. Aurivillius has kindly examined it for me, and finding it new to science, he proposes to describe it (or has already described it) under the name of *Plaxomicrus hispoides** (*Phytoeciinae*). I send with it for exhibition a specimen of the common Hispid, *Dactylispa longicuspis*, Gestro, which was taken in the same

* Mr. C. J. Gahan considers that the species more probably belongs to the allied genus *Chreonoma*.—E. B. P.

district and month (possibly on the same day). It should be noted that *all* the Sarawak Museum examples of this species of *Dactylispa* come from the region watered by the Limbang, Trusan and Lawas Rivers, all of which are adjacent and debouch into Brunei Bay.

"The little tufts of hair on the elytra of the Longicorn, so formed as to resemble the spines on the Hispid, recall the instance of another Longicorn (*Zelota spathomelina*, Gahan), exhibiting a somewhat similar development (but bearing of course an entirely different pattern from that of the Hispid-like Longicorn), on this occasion in mimicry of the spined Endomychid, *Spathomeles turritus*, Gerst. Mr. Shelford figures and records this latter instance (*l. c.*, p. 247, pl. xxiii, f. 56, 57). He also mentions the presence of the larger red and black *Hispidae* with mimetic Longicorns in his great Lycoid distasteful association, but I believe that this is the first instance

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known of a Longicorn going to the length of pseudo-spine-development on the elytra in mimicry of a Hispid.

Explanation of Exhibition.

I. Mimetic Lepidoptera.

1. The Butterfly (Fam. *Hesperidae*), *Koruthaiolos xanites*, Butler, mimicked by
2. The Moth (Fam. *Callidulidae*), *Callidula abisara*, Moore.

   Locality: near Kuching, Sarawak, April 1909. Both at the 4th mile, 'Rock Road,' the Hesperid on the 10th, the moth on the 24th.
3. The Butterfly (Fam. *Pieridae*), *Terias hecabe*, L., mimicked by
4. The ♀ of the Moth (Sub-fam. *Chalcosiinae*), *Mimeuploea* (*Pidorus*) *inclusus*, Walk.
5. The ♀ of the Moth (Sub-fam. *Chalcosiinae*), *Chalcosia* (*Cyclosia*) *hecabe*, Jord.

   Localities: Kuching, Sarawak, July 27, 1896 (No. 3), and Madihit, Limbang R., Sarawak, 1911, No. 4 on May 21, No. 5 on May 26.

II. Mimetic Coleoptera.

1. The Longicorn, *Daphisia pulchella*, Pascoe, mimic of
2. The Clerid *Callimerus bellus*, Gorham.

Locality: Matang Road, near Kuching, Sarawak, July 1911. No. 1 on the 12th, No. 2 on the 25th.

3. The Longicorn (Fam. *Lamiidae*), *Daphisia clytoides*, Gahan, synaposematic mimic.
4. The Longicorn (Fam. *Lamiidae*), *Cylindrepomus laetus*, Pasc., var., synaposematic mimic.
5. The Longicorn (Fam. *Cerambycidae*), *Caloclytus annularis*, Fab., synaposematic model.
6. The Clerid, *Callimerus mysticus*, Gorham, pseudaposematic* mimic.

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Localities: Nos. 3 and 4, Mt. Matang (3,600 ft.), near Kuching, Sarawak, June 1900, and (3,200 ft.) July 30, 1909.

No. 5, Danau, near Kuching, November 18, 1909. Also taken at Lawas among other places. A common species in Sarawak.

No. 6, Lawas, August 26, 1909.

7. The Lamiid Longicorn *Plaxomicrus hispoides*, Auriv. mimic of
8. The Clerid, *Dactylispa longicuspis*, Gestro.

Locality: R. Limbang, April 1910."

Appendix by C. J. Gahan.

Daphisia clytoides, Gahan, sp. n.

Brownish black. Head, prothorax, scutellum and body beneath with a rather dense covering of tawny-yellow pubescence, a similar pubescence forming bands and spots on the elytra; head marked with a median black band on the vertex; prothorax with four longitudinal black bands—two on the disc and one on each side;

* More probably synaposematic in view of the fact that another species of the same genus is the model of *Daphisia pulchella* (see p. lxxvi). There are in fact details in the pattern of *Daphisia clytoides* which suggest its possible secondary mimetic association with the Clerid. Observations during life would be particularly valuable in settling this point.—E. B. P.

these bands, which stop short before base and apex, are closely and rather strongly punctured; the tawny-yellow marks on the elytra consist of (1) a sutural band which widens out at the base and spreads across each elytron to the shoulder, and which also widens out near the apex, (2) a short oblique band given off on each side from the sutural band just before the middle, (3) an elongate, club-shaped spot or band running from the outer end of the oblique band towards the base, (4) a round spot on each elytron placed close to the sutural band about half-way between the middle and the apex. Metathorax with one, and the abdomen with a row of blackish spots along each side. Where the elytra are blackish in colour, they are seen to be rather strongly punctured.

Length 11, breadth 3 mm.

Hab. BORNEO: Matang, 3,600 ft.

The actual specimen here described is figured by Mr. Shelford in Proc. Zool. Soc., 1902, on p. 25 and pl. xx, f. 34.

Cylindrepomus laetus, Pasc., var.

From the type form of *C. laetus*, this variety differs chiefly by the colour of the pubescence covering the prothorax and forming the bands on the elytra, the colour being yellowish-brown instead of ashy-grey as in the type. It differs also in having the short sutural

band at the apex of the elytra continued forward to join the postero-median transverse band, and the latter is a little more arcuate than is the corresponding band in the type.

Hab. BORNEO: Matang.

This variety is figured by Mr. Shelford as "? form of *comis*" (*l. c.*, pl. xx, f. 33).

A NEW AFRICAN LYCAENID.—Professor POULTON exhibited six male examples of a remarkable Lycaenid, all captured, Nov. 22, 1910, in the Uhehe District (3,000–3,500 ft.) of German East Africa, by Mr. S. A. Neave, F.E.S. The pattern and brilliant colours, which were extraordinary in a Lycaenid, strongly suggested, on both upper and under surface, the appearance, although on a smaller scale, of an *Acraea* of the type of *A. anemosa*, Hew. Mr. Neave wrote to Professor Poulton from Mombasa, Jan. 6, 1911:—

"I had a very fairly successful journey across German East Africa.

"I got a few good Lepidoptera, the most interesting in the way of mimicry being a large Lycaenid which I do not re-

member having seen before. I took six individuals all from one spot.

"The first one I saw completely took me in (though I watched it for nearly five minutes while waiting for a net to come up) not so much by its appearance as by its attitude. It was sunning itself at the top of a grass-head with the wings expanded but the primaries making an angle of 45 degrees with the body and covering the secondaries, exactly as many Acraeas sun themselves. All the time I was watching this first specimen I was quite satisfied that I had got hold of a new *Acraea*, the idea of a Lycaenid in such an attitude and position never entering my head. I subsequently took in the same spot five others, some of them doing the same thing, others on the wing. The flight was less powerful than that of *Mimacraea marshalli*, Trim."

Mr. H. H. Druce and Mr. G. T. Bethune-Baker stated that the species was entirely new to them.

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Bred series of Acraea orestia and A. humilis.—Mr. H. Eltringham exhibited a bred series of *Acraea orestia*, Hew., containing the typical form, and also the *A. humilis* of Miss E. M. Sharpe, thus demonstrating the truth of the conclusion at which he had previously arrived as to the specific identity of these two forms. The exhibit was accompanied by an extract from a letter received by Professor Poulton from Dr. G. D. H. Carpenter, who had bred the series at Damba Island, Victoria Nyanza, and who had generously presented the specimens to the Hope Department at Oxford. Dr. Carpenter's note was as follows: "Reared, September 11 [1911], larvae found very young, feeding all together on one leaf, cheek by jowl. I took them for *alciope* larvae, and was much surprised by the ultimate result. Pupae and larvae were both exactly like *alciope* so far as I could tell, but I had no *alciope* larvae to compare with them at the time, as no idea of a different species was suggested."

Mr. Eltringham also exhibited a coloured drawing of the larva of *alciope* in order to give an idea of the appearance of the larvae from which *orestia* had been bred. He also showed three ♂ black and yellow Acraeas, one of which was the

A. circeis of Drury from Sierra Leone. The other two while differing in appearance from *A. circeis* were themselves exactly alike, but for the fact that the two tarsal claws of the second
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and third pairs of feet were equal and similar in one specimen and unequal and dissimilar in the other. He pointed out that in all the African Acraeas, except about sixteen species, the male tarsal claws were unequal. *A. circeis* was amongst the latter, and in many cases of close similarity of pattern this feature provided a ready means of distinction. In such cases, however, there was as a rule some difference of pattern correlated with the structural difference in the claws. The present case was an exception to that rule. He had hitherto regarded the form now exhibited, which was recognisably different from *A. circeis*, as *A. servona*, but the discovery of a form identical in appearance with the supposed *servona*, and differing only in the structure of the claws, raised a serious difficulty, inasmuch as the type of *servona* was a female, and since all female Acraeas had equal claws, it was quite impossible to say to which of these males the type *servona* belonged. There were female examples in the series from which the present specimens had been taken, but they were all alike. The equal and the unequal clawed forms must apparently be regarded as different species in spite of the absence of difference in wing pattern. If the females of both these species were as similar in appearance as the males the true identity of *A. servona* would never be discovered. The male armature of these species was of a very simple character, and afforded but little evidence of a specific distinction.

In answer to an inquiry from Mr. Bethune-Baker, Mr. Eltringham said that he had made many preparations of the ♀ organs, but that in this group of Acraeas they did not provide distinctive characteristics. A long and interesting discussion followed on the question of the importance of the tarsal claws as a means of specific distinction, and on the possible correlation of uneven claws in the ♂ and the abdominal sac in the ♀, in which the President, Professor Poulton, both the Secretaries, and Messrs. Gahan, Collin, Waterhouse and Janson joined.

Wednesday, December 6th, 1911.

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CONTRASTS IN COLOURING BETWEEN CERTAIN SPECIES OF BUTTERFLIES FROM THE LAGOS DISTRICT AND THEIR GEOGRAPHICAL RACES AT ENTEBBE.—Prof. POULTON exhibited a series of specimens bearing upon the view, again recently advanced, that changes of colour and pattern in allied forms are due to climate, and especially to moisture. The western specimens were all collected or bred by Mr. W. A. Lamborn, just above sea-level, in the Lagos district. The Uganda specimens were
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collected by Mr. C. A. Wiggins, at about 4000 ft., in the neighbourhood of Entebbe. The average rainfall at Epe, near Mr. Lamborn's locality, Oni, 70 miles east of Lagos, is about equal to that of Entebbe, being 60·5 inches to 59·1. The first example was *Planema epaea*, Cram., and its Uganda sub-species *epaea paragea*, Grose-Smith. In the latter the fuscous ground-colour had been greatly increased, while correspondingly reduced pale-yellowish markings represented the conspicuous fulvous of the western male and white of the western female. Thus the sexual dimorphism of pattern, marked in the west, is lost in the far duller Uganda race. Together with these were exhibited the males and females of *Papilio cynorta*, F., from the same localities. While the males showed no appreciable change, the western female was a beautiful mimic of the female *epaea* and the more eastern female (*peculiaris*, Neave), an equally beautiful mimic of the dingy-looking *paragea*. In this latter case a climatic cause could hardly be invoked, for it is unreasonable to suppose that the male and female larvae and pupae are exposed to different conditions or that they differ in their sensitiveness to climatic influence. It may well be argued, however, that we should not expect a Papilionine and an Acraeine to exhibit the same kind of susceptibility. But even the investigation of other Planemas (*Acraeinae*) at Entebbe does not support the conclusion that the pattern of *paragea* is a climatic effect. Thus it is seen in the exhibited specimens that the rich fulvous and black *P. consanguinea*, Auriv., from the Lagos district

becomes the pale yellowish and black sub-species *arenaria*, E. M. Sharpe, at Entebbe.

When we pass from the western to the eastern side of the geographical range, *Plamena epaea* becomes a duller, darker-looking butterfly; *Planema consanguinea*, on the contrary, a far lighter and paler butterfly. If, neglecting the immense difference in general appearance, attention be fixed on the fact that the fulvous pigment of the male *epaea* and both sexes of *consanguinea* becomes pale yellow in the east, we are met by the fact that the male *Planema alcinoe*, Feld., from Lagos, preserves the very same fulvous tint unchanged at Entebbe, as do the male *montana*, Butl., form of *P. aganice*, Hew., the male *P. macarista*, E. M. Sharpe, and both sexes of *P. poggei* [xci

nelsoni, Grose-Smith. Further evidence against the hypothesis of climatic influence was derived from Mr. Wiggins's series of *P. paragea*, in which were found the two remarkable specimens exhibited to the meeting. In one of these, a male captured June 26th, 1910, the yellow markings had almost entirely disappeared, while in the other, a female, taken Aug. 29, 1909, they were immensely extended, especially on the hind-wing, where the pale expanse was even two or three times as large as the white area of the female *epaea* from Lagos. Here was a single individual in which the normal change in the eastern part of the range was reversed, the insect being lighter and paler instead of dingier in appearance. Such a variety throws strong light upon the origin of mimetic resemblance; for this pale individual presents considerable likeness to *P. arenaria*, and affords the foundation upon which a close resemblance might be developed by selection. There can hardly be any example as yet known which better enables us to understand the production of mimicry between forms closely allied but superficially very different in appearance: yet in its production the operation of climatic influence is extremely improbable, and we are thrown back upon causes of variation at present unknown and mysterious.

PSEUDACRAEAS OF THE HOBLEYI GROUP ON DAMBA ISLAND AS COMPARED WITH THOSE FROM THE ENTEBBE DISTRICT.—Prof. POULTON exhibited a set of the mimetic Pseudacraeas and their

models collected by Mr. C. A. Wiggins in the neighbourhood of Entebbe, viz. :—

PLANEMA MODELS.	PSEUDACRAEA MIMICS.
macarista, E. M. Sharpe, ♂. *poggei nelsoni*, Gr.-Sm., ♂ and ♀.	*hobleyi*, Neave, ♂. Also a ♀ with the colouring of the ♂.
macarista, ♀. *alcinoe*, Feld., ♀. (This model was not exhibited.)	*hobleyi*, ♀.
tellus platyxantha, Jord.	*terra*, Neave. ♂ and ♀.
paragea, Grose-Smith, ♂ and ♀.	*obscura*, Neave, ♂ and ♀. (The ♂ was not exhibited.)

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The above series contrasted remarkably with a set of 17 Pseudacraeas collected by Dr. G. D. H. Carpenter on Damba Island, on the Equator, in the Victoria Nyanza, about 20 miles S.E. of Entebbe. Dr. Carpenter wrote of this island on Sept. 30th, 1911 : "It is practically covered with forest and jungle formed by the running wild of the banana plantations since the inhabitants were deported to the mainland." The various forms and the times at which they were captured—all except one in the jungle—are shown below :—

DATES IN 1911.	FORMS OF PSEUDACRAEA.
1st half May.	1 ♂ *terra* (typical).
,, ,, July.	1 ♀ *terra* (typical). 1 ♀* *terra* (transitional towards ♀ *hobleyi*: subapical f.w. bar white, and fulvous area reduced and pale. Slight but distinct traces of the fulvous patch at the base of the h.w. underside).
2nd half Aug.	2 ♂ *terra* (typical). 2 ♀ ,, ,, 2 ♀ ,, (slightly transitional towards ♀ *hobleyi*. Subapical f.w. bar pale in one and nearly white in the other).

* This specimen was captured on the shore.

DATES IN 1911.	FORMS OF PSEUDACRAEA.
1st half Sept.	1 ♂ *terra* (typical). 1 ♀ ,, ,, 2 ♂ *hobleyi* (1 typical, 1 with h.w. bar fulvous instead of white).
2nd half Sept. (17th–30th.)	1 ♀ *hobleyi* (typical). 1 ♀ *terra* (beautifully transitional to *obscura*). 1 ♂ *obscura* (with distinct traces of the fulvous colouring of *terra* on f.w. inner margin). 1 ♀ *obscura* (subapical f.w. bar white as in ♀ *hobleyi*, but narrower, and the remaining white pattern of the latter *very faintly* visible.

1. Proportions of the Mimetic Forms and of the Models.—The proportions in the Entebbe District are well shown by the following figures, which summarise nearly [xciii the whole of this material collected by Mr. Wiggins between May 23rd and Aug. 31st, 1909.* :—

PLANEMA MODELS.	PSEUDACRAEA MIMICS.
macarista ♂ ... 81 *poggei nelsoni* ♂, 11 ,, ,, ♀, 1 93	*hobleyi* ♂, ... 35 ,, ♀ (with ♂ colours) 1 36 (38·7 per cent. of the models).
macarista ♀, 39 *alcinoe* ♀, 11 50	*hobleyi* ♀, 28 (56·0 per cent. of the models).
tellusplatyxantha ♂, 75 ,, ,, ♀, 14 89	*terra* ♂, 7 ,, ♀, 11 18 (20·2 per cent of the models).
epaea paragea, 12	*obscura*, 0

* Quoted from "Mem. I. Congr. Internat. d'Ent., Brussels," Vol. II, p. 483, 1910. This paper contains a nearly complete list of captures, between the above-mentioned dates, of all the species concerned, except *Planema paragea* and *Pseudacraea obscura.* The proportions of these two latter were taken from a list recently prepared by Mr. C. A. Wiggins and Prof. Poulton. In the course of this work it was found that one or two days' captures had been accidentally omitted from the paper referred to above.

The percentage of the three commonest mimics is thus much higher than we should expect; but on Damba Island, so far as could be judged from Dr. Carpenter's collections between the beginning of May and the end of September, the results are far more astonishing. The only *Planema* models in the whole collection are a single female *macarista* and a single female *poggei nelsoni* in the second half of August, and a single male *macarista* captured on Aug. 8–9. All these specimens were taken in the jungle. In spite of the immense predominance of *P. terra*, not a single *Planema tellus platyxantha* appeared in the collection, nor was there a single *P. epaea paragea*. Even more striking was the absence of *P. arenaria*, by far the most abundant *Planema* in the forests near Entebbe.*
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Not only is there this extraordinary difference in the proportions of the models, but the proportions of the mimetic forms to one another are also remarkably different from those of the mainland, *terra* being far more predominant over *hobleyi* in the island than *hobleyi* is over *terra* on the mainland.

2. PROPORTION OF TRANSITIONAL FORMS BETWEEN THE MIMETIC PSEUDACRAEAS HIGHER ON THE ISLAND THAN ON THE MAINLAND.—The table on p. xcii. shows a quite unusual number of transitional forms. Transition is indicated in various directions,—between *terra* and *obscura*, between *terra* and ♀ *hobleyi*, between *terra* and ♂ *hobleyi*, between *obscura* and ♀ *hobleyi*.

3. POSSIBLE CAUSES OF THE ABOVE DIFFERENCES.—It is highly improbable that these remarkable differences are connected with climate or season of the year; for the contrasted sets of captures were made in almost the same months. The period was, moreover, long enough to exclude the effects of the seasons beginning and ending on different dates in different

* The results quoted above are not due to the captor's selection, and, so far as the limited numbers go, may be depended upon in attempting to form an estimate of the proportion of models and mimics in the jungle. This was Dr. Carpenter's first experience of these extraordinarily close mimics, and he had not at the time learnt to distinguish them from their models. He states in a letter dated Dec. 5th, 1911: "I was much surprised to hear that I had sent more Pseudacraeas than Planemas, and thought I had done the opposite."—E. B. P.

years. The most probable explanation appears to be that, in the condition of the jungle on Damba Island, there is something unfavourable to Planemas, and that, in the absence or relative scarcity of the models, the mimetic resemblance of the Pseudacraeas is no longer rigidly maintained by selection. The pattern of *Ps. terra* is found among the protean mimetic forms of *eurytus*, L., on the west coast, and even the colour as well as the pattern in a Nigerian mimic of the male *Pl. epaea.** I suggest that in an area where these mimetic patterns are less strongly selected, there is a tendency, checked elsewhere, for them to run into each other, and also to move in the direction of the western *eurytus* forms, from which there can be little doubt that the mimetic Pseudacraeas of Uganda originally developed. It is to be hoped that Dr. Carpenter may be able

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to obtain the material, by breeding as well as by capture, by which this hypothesis will be confirmed or refuted.

Observations on the Courtship of Planema alcinoe, Feld.—Prof. Poulton exhibited four males and one female of *Planema alcinoe*, captured Aug. 10th, 1911, in the forest one mile E. of Oni, near Lagos, by Mr. W. A. Lamborn, under the conditions described by him in the next paragraph, dated Aug. 13th. Prof. Poulton said that he was not aware of similar observations having been made upon Lepidoptera, in which group the unsuccessful males have often been seen to disperse as soon as pairing takes place. It is to be noted that in a family of *P. alcinoe* bred by Mr. Lamborn the males emerged Sept. 8th–11th, 1911, the females not until Sept. 16th–22nd.

"I found five Planemas in a confused mass on a thin bough. Careful examination revealed that four were males and one a female. A male and female were *in coitu*, both resting on the upper side of the little bough facing opposite ways; another male rested underneath, his head in the same direction as that of the female. His claspers gripped her abdomen immediately in front of the claspers of his more successful rival, the penis of No. 2 being extruded and forced to one

* Figured by Dr. Karl Jordan in the publication of "I. Congr. Internat. d'Ent.," 1910, Vol. II, pl. xxii, fig. 22*a*. Good examples of pattern but not colour resemblance are shown in his pl. xxiii, figs. 26*a*, 27*a*.

side. A 3rd male grasped a wing of the female so firmly with his legs that the membrane was crumpled up: he remained motionless. The 4th male grasped and crumpled up the opposite wing in a similar way, all the time making efforts to obtain hold of any portion at all of her anatomy with his claspers."

The Cocoons and Eggs of the Bombycid Moth, Norasuma kolga, Druce.—Prof. Poulton exhibited the cocoon of *N. kolga* together with the moth which had emerged from it. The compact cocoon itself was reddish, with an outer imperfect covering of yellow silk. In some cocoons, including the one exhibited, the silk of this loose and open network formed dense little masses here and there which, being bright yellow in colour, much resembled the cocoons of Braconid parasites. Prof. Poulton had written to Mr. Lamborn to inquire whether these structures were always present in the natural state, as it seemed possible that the loose covering had been lost in

the manipulation of some of the artificially bred specimens. Prof. Poulton also exhibited a wall-like mass of egg-shells in which the arrangement to "break joint," as described by Mr. Lamborn, was clearly visible. This keen observer had written, Aug. 28th, 1911—

"You will see, by egg-shells now sent, how wonderfully the eggs are disposed—in the form of a little wall, the eggs being in rows one above the other and each egg placed so as to cover the adjacent halves of two eggs below it. There is a fine opalescence too about the egg mass in a good light."

These specimens together with the remainder of those exhibited by Prof. Poulton were obtained by Mr. Lamborn at, or near, Oni Camp.

The Spherical Bodies on the Cocoons of the Hypsid Moth Deilemera antinorii, Oberth., etc.—Prof. Poulton exhibited a large family of these moths—80 in number—together with their female parent, and 67 of the cocoons from which they had emerged. The exhibit had been recently received from Mr. W. A. Lamborn, who had bred the moths from eggs laid Aug. 13–18, 1911. Concerning the habits of the larva Mr. Lamborn had written, Sept. 19th—

"In regard to the structures like Braconid cocoons I do not think there is much to add to what I have already written. The larva spins a few threads in the usual way. The hinder extremity of the body is gradually raised until it is brought to about an angle of 20° with the rest of the body, the larva meanwhile continuing to spin. When it has been in this position a few seconds the little mass is passed *per anum*, the larva ceasing work only during the actual passing of it. When several little masses have accumulated, the larva turns round, weaves silk over each and in turn drags each off by the silk and deposits it in the desired position."

In reply to further questions as to the details of the larval procedure Mr. Lamborn wrote, Nov. 12th—

"In regard to the cocoons of *Deilemera antinorii* the larva passes spheres *per anum* usually one at a time with an interval of perhaps half a minute between them. Sometimes two are passed, one following immediately on the other. When two or three spheres have accumulated at its anal extremity the [xcvii larva turns round, weaves a few turns of silk round one and drags it away to the required position, I believe by means of these silk threads. It then fixes it by a few further turns of silk, and then removes the remaining spheres one by one in a similar way. The silk spun over the spheres is white. The spheres vary in colour even when first passed, some being yellowish and often containing one or two bubbles darker than the rest, others being much paler. I think that the latter darken with age. The time occupied in spinning over a single sphere is just a few seconds, and I think the silk serves as a handle. I have not observed the whole process of cocoon formation, for it takes some hours, the larvae frequently commencing at night, and I have not seen the final stages at all, but I shall look into the various points you mention."

Concerning the cocoon of the allied southern and eastern species of *Deilemera*,—*D. leuconoe*, Hopff., Mr. G. F. Leigh had written to Prof. Poulton on Oct. 27th, 1911—

"I noticed what you say about the cocoon, and, in a short discussion some years ago at the Durban Field Naturalists' Society, I pointed out this very thing; for when I first bred

this species I actually threw away three or four cocoons of the first lot, thinking that ichneumonid parasites had emerged from the larvae. I have bred hundreds of the insects, of which there are two forms of imago, one black-and-white, the other black-and-buff. The larva is black-and-white, slightly hairy, as may be seen in blown specimens sent by me to the British Museum and Tring Museum. It feeds on a low plant, but always climbs up on to a fence, wall or trunk of a tree to make its cocoon. The larva is protected and distasteful to birds, Mantis, etc. The cocoon is formed of a substance very much like jelly, which, as long as the pupa is alive remains soft; if, however, the pupa dies the substance becomes dry and shrinks also. The pupae will live if the substance that forms the cocoon is taken off. The colour of the pupa is light brown. The cocoon-like bodies vary in tint, but are generally yellow, although I have had them white like very small pieces of boiled rice. The duration of the pupal state is very short, not more than a week. The larva is attacked by an ichneumon of apparently the same species as that which is

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bred from the three Papilios, *demodocus*, Esp., *nireus*, L., and *cenea*, Stoll. The parasitic larva, after leaving the host, spins a thread almost 1$\frac{1}{2}$ inches long, attached by one end to the twig of a tree or to a wall. At the lower end of this thread it constructs a parti-coloured cocoon—grey-and-black. There is another species of *Deilemera* I found in the Comoros that makes its cocoon in the same way. I fancy it feeds there on the small fig-trees, as I found the pupae only on those trees."

The Spherical Bodies on the Cocoons of the Tineid Genus Marmara.—Prof. Poulton said that he had been shown by Mr. J. H. Durrant the spherical bodies scattered over the cocoon of the Tineid moth *Marmara salictella*, Clemens, and had no doubt that they were secreted by the larva and passed by the anus as in *Deilemera*. It would be interesting to observe whether any of the common parasites of Tineids construct cocoons to which the spheres bear any marked resemblance. At first sight the appearance suggested is rather that of a mass of spiders' eggs such as are often seen in chinks of bark. Here, too, it is important to ascertain by

experiment whether spiders' eggs are in any way specially protected.

Although the Tineid spheres are much smaller than those of *Deilemera,* each of them is similarly made up of several bubbles, and the resemblance is so remarkably close that it is appropriate to quote in this place the observations that have been hitherto recorded concerning them. The references to *Marmara* have been kindly given by Mr. Durrant.

Clemens wrote of *M. salictella* in 1863 ("Ent. Soc. Phila.," ii, p. 7; reprinted in Stainton's ed. of Clemens' papers on "Tin. of N. Am.," 1872, p. 212)—

"It leaves its mine at maturity to weave a white, semi-transparent cocoon within some crevice of the bark of the tree on which it feeds or upon the ground. The exterior of the cocoon is covered with little froth-like globules, which resemble minute pearls."

Busck wrote of the same species in 1903 ("Proc. Ent. Soc. Wash.," v, p. 210)—

"The writer has bred it for several seasons, and gave some notes before the Washington Ent. Soc., on its unique mode

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of ornamenting its cocoon, which deserves fuller treatment. Such will be given shortly in a separate paper."

Finally in 1907 Busck stated of *Marmara opuntiella,* Busck (in "Ent. Soc. Wash.," viii, p. 97)—

"At the last larval molt it assumes the cylindrical form with normal legs and spins the characteristic cocoon with the peculiar globular ornamentations as do the other species of the genus."

The Attacks of Tachinid Flies upon the African Danaine Genus Amauris.—Prof. Poulton exhibited 5 specimens of *Amauris psyttalea,* Plötz, being all that Mr. W. A. Lamborn "obtained from 25 pupae, the rest being parasitized by *Tachinidae*" (Oct. 3rd, 1911). All 5 butterflies had emerged Sept. 20th, 1911. Seventeen dead pupae from the same company, 12 of the Tachinid flies, and a number of their puparia were also exhibited. Mr. E. E. Austen had recognized 2 species of *Sturmia* in 4 of the flies submitted to him. In the same letter Mr. Lamborn spoke of another company of *A. psyttalea*

in which "every single pupa was parasitized in this way." Prof. Poulton pointed out the bearing of these and Mr. Guy Marshall's earlier observations on the extraordinary assumption of the late Erich Haase, that the specially protected species of Lepidoptera are immune from the attacks of parasites.

Some Ant-tended Lycaenid Larvae observed by Mr. W. A. Lamborn in the Lagos District.—Prof. Poulton exhibited material illustrating the following records received in letters from Mr. Lamborn—

1.—*Myrina silenus*, F.

March 3rd, 1911.

"The food-plant, which bears a fruit much like a little fig, grows here and there in the primitive forest round Oni camp. The larva of *Euchromia lethe*, F., also feeds upon it, as well as that of a Sphingid moth. The larvae are green with white tubercles and are not very conspicuous on the food-plant, though found in all positions on it, on both sides of the leaves and frequently on growing buds at the end of stems. They pupate anywhere; frequently on the upper side of a leaf. It

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is very common to find the larvae attended by ants of various kinds, which run all over them, and the larvae do not notice them in the least even when feeding. The pupae also seem to attract ants."

2.—*Hypolycaena philippus*, F.

March 3rd, 1911.

"The larvae of all these have been found all round about Oni camp; for the food-plant grows abundantly in the clearing. The larvae are found sometimes on the upper side of a leaf even during the heat of the day, and they are leaf-green in colour. Both larvae and pupae attract ants to a remarkable degree. I have learnt that if ants are running about on the food-plant without flowers, larvae are almost certainly on it, and if there are no ants I do not trouble to make an exhaustive search. My first half-dozen larvae were placed in a box covered with fine muslin. On the following morning I

discovered that our house ants, a different species from those on the plants, had eaten a hole in the muslin and were swarming over the larvae. I then put two thicknesses of muslin over the box, but the ants again ate it through, and so now, as they do not seem to hurt the larvae, I do not trouble to remove them. The pupae are placed indifferently on upper or under side of a leaf and frequently head downwards on a stem, and ants congregate about them during the whole period of pupation. The ants work hard in an endeavour apparently to cover up the pupae with débris. They heap up little particles of sawdust, larval droppings, etc., round pupae on the floor of the box, and some attempt is even made to cover the pupae on the side walls. I found to-day on the outside of the roof of the box a little collection of débris with which ants were busily covering a fissure in the wood which led through to a pupa on the inner side of the roof. Some larvae have pupated on the floor of the box, but this does not affect the wing-development of the butterflies, for they always seem to find a suitable position in time. I have from time to time lost other butterflies which have not been able to develop properly owing to their pupae having fallen down. By the way, the larvae are usually green, but

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I now have a scarlet one of, I believe, the same species. The pupae are sometimes green and sometimes perfectly grey-coloured."

3.—*Oboronia punctata*, Dew.

The observations on this remarkable species are of special interest—

Sept. 10th, 1911.

" I made a little discovery to-day which has much delighted me. In accordance with your suggestion I have been investigating the contents of ants' nests and to-day found two Lycaenid larvae. I must write about this when I get perfect insects. The particular nest of ants was constructed on the head of a plant [*Costus afer*] which had borne numerous bell-shaped flowers. These were eaten down more or less level, and then the ants had piled up earthy-looking vegetable

débris over the mouths of the remaining parts of the flowers. I found the larvae each thus sealed up loosely in the base of what had been a flower. I removed the débris and carefully brought the flower-head home, and the ants are now again moving quietly to and fro on it. I think these larvae may be Oboronias, for these are the flowers which seem to have a special attraction for them, as I think I have mentioned."

Sept. 19*th*, 1911.

"You will have received my first *Oboronia punctata* from a pupa. This was found in the calyx of one of the flowers which I have mentioned, the opening of which was sealed by débris deposited by ants. I will not attempt to describe the flowering head, for I intend to send one; but, roughly, there are a number of bell-shaped flowers springing from a common dome-shaped base. Only one or two of the flowers come into bloom at once, and over the other immature buds ants build up a covering of the débris, themselves occupying the interstices between the buds and keeping their larvae and eggs there. I have now found several *Oboronia* larvae, some with the ants in the interstices, and others in calices from which the flowers have fallen out or the flower-buds been eaten away.
cii]
The larva feeds on the flower-buds, biting out a circular aperture through the calyx, by which it obtains ingress, and gradually eating the bud out till only the empty calyx remains. The ants, too, enter with the larva and crawl all over it, stroking it with their antennae, and they are very constant in their attentions to the pupa too, several always remaining with it, though the calyx which contained it was put away without anything else in a glass-lidded box. Some of the ants' nests contain a large number of individuals, and I have not been able to look them through satisfactorily as yet, but I have obtained 6 larvae out of 7 nests, 2 nests having 2 larvae apiece. I must get some help before I can explore any more, as the ants bite, and I do not want to cut off the flower-heads, as there are not a great number. I am trying now to get a family of Oboronias, but it is likely to be difficult, as the food-plant dies so soon. I think this plant must be that determined

at Kew as *Costus afer*, Ker.-Gawl (*Scitamineae*), a specimen being sent home in the first consignment of plants."

The flower-head was sent to Kew and determined as *C. afer*, *sens. lat.*

The next letter (Oct. 3rd, 1911) gave an account of Mr. Lamborn's attempt—in all probability a successful one—to breed Oboronias from a known parent—

"I believe the Oboronias now sent to be the offspring of the female whose remains are packed with them. She was eaten by the ants. With a view to obtaining a family of them I selected a good head of the food-plant in our clearing at Oni, and cleared it of all ants and their débris, removing at the same time all dead matter. I went over it again the next day, and the following morning I pushed it through a hole in the floor of a box, closing up all the space round it with cotton-wool. I then put the *Oboronia* female inside and covered the box with muslin in front. In the course of a couple of days the ants got in and formed a nest composed of sawdust, etc., over the flowering head. The butterfly died and was mostly eaten up by the ants. I was not able to look for eggs or larvae, but when I did pick the flowering head to pieces I found a few pupae which I feel confident must have been the progeny of that insect."

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The following observations, recorded in the same letter, show that all ants are not equally benevolent in their treatment of the Oboronias—

"On Oct. 5th I obtained a half-grown larva of *Oboronia punctata* and placed it on a stem on which 'tree driver' ants [evidently *Oecophylla smaragdina*, F., race *longinoda*, Latr.] were running up and down. The first driver that came along investigated it hurriedly with his antennae and then gripped its anal extremity in his jaws and held on. More ants came down. Some passed on without noticing the larva, others just touched it with their antennae and then went on. Seven or eight thus passed it by, and the next ant stood over its hind extremity and discovered on the dorsal aspect of, I think, the second segment some material which it ate. I actually saw it take up the semi-solid material and

eat it. This ant then ran off. The larva meanwhile had been endeavouring to crawl away, but it was firmly anchored to one place by the ant which had seized it. Another ant then came along and seized it by the head and dragged so that it became much extended. Two more ants then seized it at the sides. At this point I was obliged to come away; but they must have killed the larva, for it was very feeble when I last saw it, and they doubtless ate it."

This uncompromising treatment of the larva of *O. punctata* is all the more interesting because W. M. Wheeler ("Ants, their Structure, Development and Behavior," New York, 1910, p. 358) speaks "especially" of *Œ. smaragdina*, when mentioning the "principal attendants" of Lycaenid larvae. This distinguished authority continues:—

"*Œ. smaragdina* in that country [India] and in Australia, is, in fact, constantly found with many species of the caterpillars and often keeps them in the silken nests and 'cow-sheds' described in a previous chapter."

A postscript, dated Oct. 9th, to the letter last quoted, records that "a moth larva also lives on the *Oboronia* plant among the ants. An imago has just come out." Mr. Lamborn furthermore states that the ants pay no attention to these larvae, which are probably protected against them in some way. Examples of the moth, the Pyralid (*Schoenobiinae*) civ]
Obtusipalpis saltusalis, Schaus, were exhibited with the Oboronias and the flower-head.

4 *and* 5.—*Lycaenesthes larydas*, Cram., *f. kersteni*, Gerst., *and L. sylvanus*, Drury.

Bred examples of these two species were also shown. Mr. Lamborn had recorded, Oct. 16th, 1911, of ten larvae of *larydas*—of which only a single specimen survived and produced, on Oct. 10th, the exhibited imago—that they had been "carefully attended by ants." Of the two *sylvanus*, emerging Oct. 11th and 12th, he had written in the same letter, "these larvae also were attended by ants: in fact, the presence of a considerable number of ants attracted my attention to them."

Prof. Poulton said that he had written to Mr. Lamborn, asking him to send specimens of the actual ants in attendance on each species of Lycaenid larva, as their determination would add immensely to the value of these most interesting observations.

The Food of the Carnivorous Lycaenid larva, Spalgis lemolea, H. H. Druce (S-signata, Holland).—Prof. Poulton exhibited specimens and gave an account of observations sent by Mr. Lamborn, which threw further light on the letter written Jan. 1891, by the Rev. A. C. Good, Ph.D., from West Africa—a letter from which Dr. W. J. Holland had inferred that the larvae of *S. lemolea* are aphidivorous ("Psyche," vol. vi, 1892, p. 201). The following extracts from Mr. Lamborn's letters, together with an investigation of his material, indicate that their food consists of *Coccidae.*

"*Sept. 17th,* 1911.

"I have now found another kind of Lycaenid larva, perhaps *Spalgis lemolea,* consorting with aphides or tiny *Coccidae.*"

"*Sept.* 19*th.*

"My newest Lycaenid larvae were found on Sunday afternoon, Sept. 17th, associated on the under side of leaves with other insects which I believe to be Coccids. I must write of

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them when the butterflies emerge, but I believe they will turn out to be *Spalgis lemolea,* H. H. Druce, for I have seen several of these near the tree in the clearing, and have not made out why they come there in the face of a strong breeze which is now blowing almost constantly."

"*Oct. 3rd.*

"All the larvae were found among Coccids on a shrub in Oni clearing. I will send Coccids. Each larva bore a covering of grey material, which looked to me as if composed of cast skins of Coccids; and I think they must have eaten these or their products, for they did not eat leaves. I am told that the plant they were on is a species of *Croton*, but I

rather doubt it. The larvae were all found on the under side of leaves, and always among the Coccids."

Rev. A. C. Good, in the letter referred to above, described these Lycaenid larvae as follows: "The body was all covered over with a whitish substance, not a part of the body, and which I took to be the remains of plant-lice with which the underside of the leaves on which the larvae were found abounded. I think that these caterpillars must have fed upon these white plant-lice, for I could not detect that they had eaten the leaves" (*l. c.*, p. 202).

One of the larval skins sent by Mr. Lamborn has been examined by Mr. R. S. Bagnall, who finds that the grey material is "mostly composed of what I presume to be the 'woolly' excretion of a Coccid, but also contains the remains of an insect which I regard as a Coccid—chiefly on account of the short antennal joints, short tibia and single-jointed claw."

Prof. R. Newstead, who has examined Mr. Bagnall's preparations, wrote on Jan. 10, 1912—

"The remains in part (portions of detached legs and antennae) are undoubtedly those of a species of *Coccidae* belonging, I believe, to the *Dactylopiinae* and nearly related to one of the following genera: *Dactylopius*, Targ., *Pseudococcus*, Sign., or *Eriococcus*, Targ. The numerous long hairs attached to the fragments of skin are, however, quite unlike those of any species of Coccid with which I am familiar; indeed, they

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seem to be quite unique, and may belong to a totally different insect."

Dr. K. Jordan remarked that it was quite surprising that Prof. Poulton's correspondents in Uganda got so many specimens of *Pseudacraea* while that genus is generally scantily represented by individuals in West African collections. He further observed that among the specimens exhibited were some intermediates, which supported his contention that *obscura*, *terra* and others are only forms of one species.

EXTRACTS FROM THE PROCEEDINGS

OF THE

ENTOMOLOGICAL SOCIETY OF LONDON

(February 7th—December 4th, 1912).

Wednesday, February 7th, 1912.

Geometrid Moths of the genus Aletis, and their mimics from the neighbourhood of Entebbe. — Prof. Poulton exhibited a large but not quite complete series of the members of this important combination collected, between May 23, 1909 and September 14, 1910, by Mr. C. A. Wiggins, D.P.M.O. of the Uganda Protectorate. The specimens had been collected just as they were met with, and in sufficient numbers to give some indication of the proportions. By far the most abundant species was *Aletis* (*Leptaletis*) *erici*, Kirby (56 examples). *A. helcita*, Clerck, although much commoner in collections, was comparatively a rare insect (4). The explanation of its prominence in collections is probably to be found in the fact that *helcita* is rather larger and of a richer colour than *erici* and has been mistaken by collectors for fine specimens of the common species. There are in the British Museum two rows of *helcita*, but only three examples of *erici*. Another common species of *Aletis*—paler and smaller than either of the above—was *Aletis* (*Leptaletis*) *forbesi*, Druce (11). The following mimics were also present, all of them in very small numbers: the Hypsid moth *Phaegorista similis*, Walker (2), the female Agaristid moth *Xanthospilopteryx poggei*, Dewitz (1), the Nymphaline butterfly *Euphaedra ruspina*, Westwood (2), the Lycaenid butterfly *Telipna nyanza*, Neave (1). The proportions of the three species of *Aletis* seem to be about the same in the Lagos district, where Mr. W. A. Lamborn has bred

erici and *helcita*, and finds that their caterpillars have different patterns, and that *erici* is gregarious and *helcita* solitary in the larval state.

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HYPOLIMNAS (EURALIA) DUBIUS, BEAUV., A MENDELIAN DOMINANT, AND H. (E) ANTHEDON, BOISD., RECESSIVE.—Prof. POULTON exhibited part of an all-*anthedon* family recently bred by Mr. Lamborn at Oni Camp seventy miles east of Lagos, from an *anthedon* female parent, and part of an all-*dubius* family also bred from an *anthedon* female. Both families were amply large enough to preclude the possibility of accident. The facts indicate that in the first family a recessive female had paired with a recessive male, in the second that a recessive female had paired with a dominant male. There can be little doubt that the pattern of *anthedon* conforms more closely to that of the genus than the pattern of *dubius* and that the dominant form is therefore the more recent development.

BUTTERFLIES A NATURAL FOOD OF MONKEYS.—Prof. POULTON read the following note received in a letter from Mr. W. A. Lamborn, November 17, 1911 :—

"Our District Commissioner, Captain Neal, who occasionally spends a few days with us [at Oni Camp] tells me that he has several times seen 'dog-faced monkeys,' (not baboons but probably mangabeys), squatting beside mudholes, such as butterflies of some kinds resort to in large numbers in the dry season, and catching them one after the other and eating them. It occurred to me that this evidence might be valuable as showing that butterflies may be a natural food of monkeys."

THE URTICATING HAIRS OF A LASIOCAMPID LARVA DISSEMINATED THROUGH THE AIR.—Prof. POULTON exhibited specimens of the Lasiocampid moth *Mimopacha gerstaeckeri*, Dewitz, bred from the caterpillars referred to by Mr. Lamborn in the quotation from his letter printed below. Prof. POULTON said that although the subject had been extensively discussed he thought it was important to show that the hairs were a powerful defence against natural enemies, and also that they were spread through the air—a fact he had himself observed

in studying the cocoons of *Porthesia similis*, Fuessly. Although he had been careful to touch the cocoons only with the tips of the forceps he well remembered the irritation which had been caused, especially on the neck beneath the collar.

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"A very large company of these larvae was pointed out to me by the native clerk, on the trunk of a tree in the village 1½ miles away [from Oni] on October 18. I had the tree felled and collected them and they formed cocoons between October 20 and 24. The hairs on the larvae are intensely urticating, and, as they come off readily, float in the air if there is any draught. They get into one's eyes and produce a troublesome conjunctivitis. The cocoons are massed together side by side and are covered with the downy hairs from the caterpillars so that an even surface is produced, and the hair comes off them very easily too. As I kept feeling skin irritation as a result of hairs blowing about, I placed the boxes outside, and the female Mona must have gone to investigate the cocoons, for I found one torn open and lying on the ground, the pupa being there but damaged. The monkey suffered very badly for her curiosity, for her eyes became so swollen and inflamed that she could hardly see out of them, and the hairs were so urticating to her skin that she rolled on the ground trying to scratch herself with all four feet at the same time, and it was some days before she was herself again. I still left the boxes outside but none of the other monkeys went near them. Nov. 17, 1911."

THE ANAL TUFTS OF THE FEMALE GLUTOPHRISSA PROTRUDED DURING COURTSHIP.—Prof. POULTON drew attention to the following observation recently made by Mr. Lamborn at Oni:—

"On December 27 I saw a male *Glutophrissa saba* courting a female. She was resting on a leaf with wings expanded. Her abdomen was raised to an angle of rather more than 45° to the thorax and two little tufts very similar to those possessed by male *Danainae* protruded from the anal extremity. The male fluttered round her very closely, occasionally

settling on her wings, though he still continued fluttering while touching her. He eventually became alarmed at my presence and flew away. Dec. 29, 1911."

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"The Study of Mimicry (Batesian and Müllerian) by Temperature Experiments on two Tropical Butterflies," by Lieut.-Col. N. MANDERS, R.A.M.C., F.Z.S., F.E.S.

A long and important discussion arose on many points in connection with the last paper, of which a full report is appended.

Prof. POULTON said that Col. Manders was much to be congratulated on the positive results that he had obtained in both *D. chrysippus* and *H. misippus*, female. Furthermore the indication that the female of *D. chrysippus* was more sensitive than the male was of the highest interest. When Col. Manders first expressed the intention of making these experiments the speaker thought they were rather in the nature of "a forlorn hope" and the results were as surprising to him as they were interesting. He felt that Col. Manders had made out a case for reconsidering the conclusion (which Prof. Poulton had published in Trans. Ent. Soc. 1902, pp. 475–6, 482–4) that the type form of *chrysippus* was older than the *dorippus* form. The reasons for this conclusion still appeared to him to be strong as well as numerous, but the whole subject required to be reinvestigated in the light of these new results.

When we compared *chrysippus* with its form *dorippus* and the female *misippus* with the form *inaria*, it was quite clear that both forms differ from their types by the omission of a part of the pattern, and in no other way. Hence the type should be a Mendelian dominant in both species, as Rev. K. St. Aubyn Rogers had shown to be probably the case in *H. misippus* (Proc. Ent. Soc., 1911, p. xliv). But Mendelian dominance did not help towards the phylogenetic solution; for, accepting the generally received "presence or absence" hypothesis, it was obvious that a newer form may arise from an older by the addition (= dominance) or the omission (= recessivity) of a factor.*

* Bateson, "Mendel's Principles of Heredity," Cambridge, 1909, p. 278.

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The results of Col. Manders' experiments upon *misippus* did not seem to point uniformly towards *inaria* as the older form; for although the replacement of black by fulvous in the apical region of the forewing, and the overspreading by fulvous of the subapical white bar, supported this interpretation, the form and increased size of the bar itself suggested an opposite one. It was to be observed that the bar is unusually developed in the specimens which had been exposed to heat, and that its basal margin (viz. that turned towards the cell) possessed a remarkably bold zigzag outline. The shock of the experiment had therefore in some respects carried the individuals towards *inaria*, but in other respects had carried them further away from it.

With regard to Col. Manders' conclusion that the mimicry was simply an accidental resemblance of no bionomic significance, Prof. Poulton said that, if this were found to be true of the female forms of *H. misippus* he did not see how the theory of mimicry could be sustained at all. If these females, in departing so immensely from the ancestral pattern preserved by their male, had undergone these changes without relation of any kind to the corresponding forms of the Danaine butterfly regarded as their model, he would be prepared to look on all mimicry as accidental. He thought that Col. Manders and those writers who agreed with him, expected too much when they sought for evidence of the preferences of insectivorous birds. Such inquiries were extraordinarily difficult and wearisome, and a large proportion of the labour must inevitably lead to negative results. Prof. Poulton felt convinced that mimicry was an advantageous resemblance, not because of the direct evidence but on account of the enormous and ever-increasing mass of facts which received an interpretation on this hypothesis—for the same reasons, in fact, which justified a belief in evolution itself. No other hypothesis as yet proposed could be reconciled with the facts, and it was extremely improbable that any hypothesis as yet unknown would supply the interpretation of resemblances so numerous, so wide-spread, so well known, and so much studied and discussed. At the same time he was always urging his

correspondents to seek for direct evidence on every possible [ix
opportunity. Although he disagreed with Col. Manders' opinion on this point, he wished, in concluding his remarks, again to congratulate him on the solid results he had obtained and shown to the meeting.

The Rev. G. Wheeler challenged the position referred to in the paper that, because shock has been shown in some cases to produce atavistic results, there is anything inherently improbable in its producing in other cases an impetus in the direction in which development is tending. He maintained that this might be expected to depend on two factors, one internal the other external to the organism affected; first whether the organism subjected to the shock had reached a stage in which the tendency to new development was stronger than the atavistic tendency, and secondly whether the nature of the shock was in the direction of the forces (whatever they might be) tending to produce the newer form, or in the direction of those tending to check such development.

Mr. Merrifield said that his experiments on *Rumicia phlaeas*, to which Col. Manders had referred, were on the pupae, not the larvae. He had not at that time realised, as he had done since, the important effect of temperature in the larval stage. Applied to pupae it had an effect on the general colouring of the imago, very marked in the case of many of the "Thorn" moths, and other *Geometridae*; a high temperature in the later part of the pupal stage tended to produce a chestnut colouring, verging on orange, a low temperature, darker colouring approaching chocolate. But in these species, which were double-brooded, and in the double-brooded butterfly *Araschnia levana*, the most complete effects, not merely in colouring but in habits, were produced in the larval stage, and especially in its earlier instars; larvae of either of the two broods of *A. levana* could thus all be converted by the appropriate temperature into the other seasonal form—into the winter phase with its long fixed pupal period, producing in spring a butterfly resembling in appearance a small "fritillary," or into the summer phase (*prorsa*) with its very brief pupal period, resembling a small *L. sibylla*. As regards "shock" it

appeared to be in favour of that view that when the temperatures to which the pupae were subjected were extreme—below
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freezing point, or considerably above 100° F.—the effects in appearance produced by such cold and heat were very similar. Prof. Standfuss and Dr. E. Fischer had both, he believed, suggested that as regards these different temperatures the one brought out past atavistic features, the other developed future anticipatory ones. That was a point on which he could form no opinion, so he must be content with the word "shock," without being able to enter on the question of the rationale of its operation.

He could not refrain from thanking Col. Manders for his paper and for its judicial tone, recording observations, which, from their impartial character would be of so much assistance to all in arriving at due conclusions on the probable explanation of the facts observed.

Dr. Chapman congratulated Col. Manders on his success in carrying out a valuable and difficult experiment. He said that in interpreting the result as showing that *dorippus* is the ancestral form, we overlooked certain considerations, or hypotheses, that, though unprovable, like mimicry itself as Prof. Poulton had just told us, still similarly enabled us to form a connected picture of otherwise isolated and even contradictory phenomena. The hypothesis, as applied to *chrysippus*, pictured it and *dorippus* as having in their past history (no matter which be the older form) frequently crossed with each other, and as subjected to alternative conditions either by migration or by change of climate, so that at the present day an individual, say of *chrysippus*, had ancestors that were often pure *chrysippus*, often pure *dorippus*, and though it may be in an area where *dorippus* does not occur, it still possesses, inherited in its tissues, the materials for producing under a suitable change of environment the race *dorippus*, deeply recessive though the *dorippus* inheritance may be—recessive of course not in any strictly Mendelian sense.

This view of the relation of dimorphic forms to each other seemed to afford the only possible explanation (not of why, but) of how melanic races appear in a very few years, on a

change of conditions. *A. betularia*, when apparently a pure race, had probably had in its ancestry very many not only crosses with *doubledayaria*, but actual changes from *betularia* [xi to *doubledayaria* and back again. Such an alternation of inheritance probably went back not to the beginning of *betularia* as a species, but much further, to a time when the present genus, subfamily, or even family, was represented by one ancestral species, or even further.

All dimorphic or polymorphic forms might be represented as two (or more) forms combined together, as dominant and recessive, the dominance not being conditioned as in the Mendelian relation purely by inheritance, but by the environment.

Levana and *prorsa* had been shown by Mr. Merrifield to be quite interchangeable at an early larval stage. As the change of conditions necessary had an annual cycle, there was the appearance, without the fact, of an alternation of generations. The regular change however kept each form ready to appear at once; but in the case of our melanic forms, or of *chrysippus*, the changes of environment were not annual but rather secular, so that in the intervals the form that is for the moment recessive receded more and more, and conceivably might be eliminated, but in the result a change of conditions operated gradually in bringing it to the front again.

That this semi-Mendelian character of dimorphism goes back far into the ancestry of dimorphic species was clear from the circumstance that seems fairly obvious, that each form of a dimorphic (or polymorphic) group is naturally selected apart from its associate, and (by selection) resents the natural tendency for the two forms to coalesce by inheritance from each other. Sexual dimorphism might possibly be the most ancestral form of dimorphism, and from it other forms might have arisen. At any rate, it fell in with the same views of dimorphism that he had attempted to sketch, but which doubtless would need a long essay to illustrate clearly, and without which it would not perhaps be easily appreciated that the same mechanism exists whether the dimorphism be apparently alternative or secular, whether the distinct forms

occur together in one race or in different localities as different races, though in the latter instance it might be difficult to say whether we have a dimorphic species, or two distinct geographical races either of which should present traces of the common xii]
ancestor but not of the other form. The conclusion from Col. Manders' experiments therefore was that if *chrysippus* and *dorippus* are geographical races and not dimorphic forms *dorippus* is the essential form, if they are dimorphic forms similar experiments with *dorippus* should yield specimens with some definite *chrysippus* aspect.

Wednesday, March 6th, 1912.

THREE FAMILIES OF P. DARDANUS, BROWN, BRED FROM HIPPOCOON, F., FEMALES IN THE LAGOS DISTRICT BY W. A. LAMBORN.—Professor POULTON exhibited the first of these families and a part of the second. He stated that these three families were the first successful attempt, outside Natal, to breed *P. dardanus* from a known female parent. In the Durban district the form *cenea* had always predominated in the female offspring bred from a *hippocoon* parent, while in the Lagos district the female offspring of *hippocoon* were themselves always *hippocoon* in all three families bred by Mr. Lamborn,—a result which harmonised with the presence of *Amauris niavius*, L., the model of *hippocoon*, and the absence on the Nigerian coast of all the other Natalian Danaine models of the female *dardanus*, except *Danaida chrysippus*, L. [xiii

The following notes and observations on the three families of *dardanus* had been extracted from letters written by Mr. W. A. Lamborn to Professor Poulton :—

"Oni Camp, 70 miles E. of Lagos,
"*Nov.* 27, 1911.

"I send all that remains of the female parent of my second *dardanus* family, for I took the female Mona with me while I was doing some gardening, and she ran off when my attention was occupied and took the butterfly out of its box before I

could get near her. However, I expect the fragments will serve their purpose, and I have quite a good number of larvae. I am catching all these female *dardanus* in the same neighbourhood near three native villages close together 1½ miles off. This is doubtless because lime-trees are plentiful there and not elsewhere in the bush."

"*Dec.* 4, 1911.

"My visit to Lagos was as usual disastrous from an entomological point of view; for most of my *Planema* larvae died, 4 new Psychid moths (males) died and were eaten by ants, and my *dardanus* males have lost their 'tails' and are otherwise damaged. However, all the first family of *dardanus* are out, save 3, and all the females are of the *hippocoon* form. There are enough undamaged males for show specimens. The man who volunteered to look after them explained their damaged condition on the ground that they had emerged and were flying before he was up in the morning.

"I watched all the others come out. They did so almost uniformly at about 8 a.m. and were ready, both males and females, to fly at about 9.30. None came out later in the day.

"I am satisfied that the freshly emerged males were more on the alert against possible danger than the females; for if one approached, even when the wings were wet and flaccid, the males dropped down and attempted to crawl away, whereas the females did not betray alarm.

"The imagos were able to emerge and develop, whatever the attitude of the pupa. Some having an insufficient girdle were suspended head down, and two or three were on the floor of the box."

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"*Dec.* 17, 1911.

"My two other families of *P. dardanus* are now pupating. I am disposed to think that the females oviposit more readily when confined in a large box than when cramped up in a small one. In common with such other female Papilios as I have observed ovipositing,—*nireus*, *demodocus*, *menestheus*, and *policenes*—they do so while still fluttering on the wing, and I think that if their movements are hampered, they get

frightened and exhausted by coming into constant contact with obstacles.

"You will have seen by now the truth of your prophecy that all females would be *hippocoon*.

"By the way I find difficulty in getting captive females to feed, but they will sometimes take weak sugar solution off the petals of flowers and one fed freely on sugar stirred up in muddy earth."

"*Dec.* 29, 1911.

"I notice that the first signs of colour in the pupal wings are visible at from 7 to 8 p.m. on the day preceding emergence. Changes go on so rapidly that by 9 p.m. it is possible to determine the sex of the pupa from colour alone, and all these imagos came out early in the morning like those of the first family. Before the change in colour the pupa is green and is so well harmonised with its leafy surroundings that in cutting off twigs bearing pupae to pin up I accidentally cut into a pupa which I had not perceived.

"I imagine that this late appearance of pigment must be of great value as tending to ensure the safety of the pupa. I have never found *dardanus* pupae in natural surroundings, but I feel sure that when pigment has developed, they must be ever so much more apparent to enemies.

"By the way all females so far are *hippocoon*."

"*Jan.* 1, 1912.

"All are *hippocoon*."

The *hippocoon* female parent of the first family tabulated below had been captured Oct. 19, 1911, oviposited Oct. 21–23, and died Oct. 27.

The parent of the second family had been captured Nov. 17, oviposited Nov. 19–21, and was killed by the Mona Nov. 21.

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The parent of the third family had been captured Nov. 24, and was found dead and eaten by ants Nov. 30. Oviposition was observed Nov. 26.

The dates of emergence of all the offspring and of pupation of the first family are printed below.

FAMILY I.

Date of Pupation	Date of Emergence.	No. of ♂ offspring.	No. of ♀ offspring. All *hippocoon*.
1911. November 17	1911. November 30	5	2
,, 18	December 1	3	3
,, 19	,, 1	2	
,, 19	,, 2	3	4
,, 20	,, 2		1
,, 20	,, 3		3
,, 24	,, 6	2	1
	Totals	15	14

FAMILY II.

Date of Emergence.	No. of ♂ offspring.	No. of ♀ offspring. All *hippocoon*.
1911. December 24	1	2
,, 25	1	3
,, 26	4	3
,, 27	3	3
,, 28	2	1
,, 29	2	1
,, 30	5	
Totals	18	13

Family III. Date of Emergence.	No. of ♂ offspring.	No. of ♀ offspring. All *hippocoon*.
1911. December 26	1	
,, 27	4	3
,, 28	3	2
,, 29	2	3
,, 31	2	2
1912. January 1	1	
Totals	13	10

Professor Poulton pointed out that the three families differed in the details of the pattern, thus showing that small features were hereditary—a very important consideration in the attempt to understand the growth of a mimetic likeness. In this respect these three families from the West Coast supported the conclusions previously arrived at from the study of Mr. G. F. Leigh's specimens (see Trans. Ent. Soc., 1908, pp. 443–445).

1. The "anal gap" in the sub-marginal black band of the hindwing was widely open in all the males of Family I; was widely open in 6, narrower in 2, and closed in 10 males of Family II; widely open in 2, narrower in 2, and closed or very nearly closed in 9 males of Family III.

2. The *hippocoon* females of Family I possessed a larger white patch on the hindwing than those of II and III. This effect, which tended in the direction of Eastern and South-eastern forms of *hippocoon*—mimics of the *dominicanus*, Trimen, form of *Amauris niavius*—was produced in part by the lightening to grey of the internervular black ground-colour, and in part by the extension outwards of the white scales into the same internervular spaces. A corresponding effect was visible on the under surface. The female parent also possessed a strongly

developed hindwing patch, although the condition of parents [xvii II and III was such as to prevent any accurate comparison. The female offspring of both these were remarkably uniform in the possession of a small patch like that of the Danaine model. The fact that the difference in the pattern is undoubtedly hereditary made it possible to understand the gradual origin of the Eastern *hippocoon* from the Western or *vice versa*.

3. The white spot in the forewing cell of the *hippocoon* females of Family I was small and divided, hourglass-like, by a constriction, in 8 specimens. In 11 females of Family II and in 8 of Family III the same spot was greatly lengthened by an additional terminal section, generally separated from the rest of the spot, and very minute in some individuals (especially so in Family III). The condition of the parents unfortunately prevented any accurate study of this marking, but there could be no doubt that the hereditary tendencies of Family I differed from those of Families II and III in this as in the features described in the two preceding paragraphs.

MONKEYS EATING BUTTERFLIES.—Professor POULTON drew attention to the following letter, received by Mr. W. A. Lamborn from Captain H. V. Neal, giving further details in support of the statement in the Proceedings on p. iv.

"Epe [50 miles E. of Lagos],

"*Jan.* 22, 1912.

"You have asked me about monkeys eating butterflies. This is very common, as every native will tell you. I have seen it myself. The monkey runs along a path, sees some butterflies fluttering round some filth, goes very quietly, and seizes one by the wings, puts the solid part [body] into his mouth, and then pulls the wings off. The poor butterfly goes down like an oyster. Of course you know that butterflies are very dirty feeders. Perhaps you have tried your own monkeys with a few butterflies. The dog-faced baboon and the large brown monkey with a very long tail, which seems to be the most common species in this colony, are great butterfly-eaters. The little spider-monkey also considers a butterfly a

treat, and prefers one to a spider. I think I have told you the tale of an old native lady at Akwe [?] who saw me

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catching butterflies. A few days after this she arrived with a calabash full, but all the wings had been pulled off!"

DETERMINATION OF THE COCCID FOOD OF THE LARVA OF SPALGIS LEMOLEA.—Professor POULTON said that he had now submitted to Professor R. Newstead some of the Coccids which formed the food of *S. lemolea*, H. H. Druce. They had been sent in spirits by Mr. W. A. Lamborn, and, although unfortunately badly attacked by fungus, had been placed without hesitation in the genus *Dactylopius* by Professor Newstead, who had written, Feb. 19, 1912:—

"I have now examined the material bearing the label, 'With 457 Lycaenid larvae (*Spalgis lemolea*),' with the following results:—

"1. The Coccid is undoubtedly a species of *Dactylopius*, Targ.-Tozz., and, as far as I can judge by the somewhat imperfect condition of the preparations, the species is identical with *D. longispinus*, Targ.-Tozz., one of the common and widely distributed 'Mealy Bugs.' Only four examples (1 nymph, 3 adult females) were discoverable on the leaves, and all of these are badly infested with a microfungus of some kind—the body cavity being completely filled with hyphae or some other phase of the fungus; so that the morphological characters of the integument are almost completely obliterated; but, in spite of this, the salient characteristics of the insect are visible. The microscopical preparations are all *marked* A.

"2. An example of No. 1 completely destroyed by fungus. *Slide marked* B.

"3. Lepidopterous larva found buried in silken web. *Slide marked* C.

"4. Portion of silken web taken from the surface of the leaves. This contains the remains of the *Dactylopius*, plant hairs, frass and the spores of a fungus. *Two slides marked* D.

"5. The same as D, but stained. In one of the preparations you will find a bundle of the long hairs to which I called

attention in my former communication. They do not belong to either the *Dactylopius*, the Lepidopterous larva or the plant. They are quite unknown to me. *Two slides marked* E."

EURYTELA DRYOPE, CRAMER, SHOWN TO BE DISTINCT FROM E. HIARBAS, DRURY, BY W. A. LAMBORN.—Professor POULTON [xix exhibited examples of the above-named species, bred by Mr. W. A. Lamborn in the Lagos district. The cases of the pupae from which the butterflies had emerged were also exhibited, and retained their original form with a high degree of perfection.

It was obvious that the lateral extension of the pupal wings, as seen from a dorsal view, was greater in *hiarbas* than in *dryope*. Mr. Lamborn had also bred considerable families—of *dryope* twice, and *hiarbas* once—from known female parents. The *dryope* parents produced nothing but *dryope*, the *hiarbas* nothing but *hiarbas*. It was therefore almost certain that the two forms were distinct species, at any rate in the Lagos district, although in view of Mr. G. F. Leigh's records of their capture *in coitu* in Natal (Proc. Ent. Soc., 1909, pp. xxxv, xxxvi) it would be of much interest to repeat Mr. Lamborn's investigations in this part of the continent.

FURTHER CAPTURES OF PSEUDACRAEAS, ETC., ON DAMBA ISLAND, NEAR ENTEBBE, BY DR. G. D. H. CARPENTER.—Professor POULTON exhibited specimens captured on Dec. 3, 10, and 17, 1911, by Dr. Carpenter, in the primitive forest which still exists in the centre of Damba Island. The following notes and observations had been received from Dr. Carpenter—

"*Dec.* 3, 1911.

"I had such an extraordinarily interesting morning's collecting to-day, that I am sending some of the specimens straight away, for your bionomic series, to show that models and mimics do fly together.

"Within the last few weeks I have found a way of getting into the primitive, untouched forest in the centre of the island. Hitherto I have only collected in the 'jungle' formed by the overgrown banana-plantations at the edge of the island. To-day I went into the forest proper, and was

well repaid. It was a fine morning—the second after nearly a fortnight of dull wet weather—and butterflies were numerous. The ones I send you are only those of the mimetic associations;—the others (including some Lycaenids and a Hesperid I have not sent before) will follow in ordinary course. I was collecting from 9.15 a.m. to 1.15 p.m. up and down a game-track for about the length of half a mile."
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The same letter also contained the following notes on the habits and occurrence of species entering as models or mimics into the great *Planema*-centred combinations of Uganda.

"*Planema paragea*, Grose-Smith. In deep shade. It flies *very* feebly, though if struck at and missed it is active.

"*Planema macarista*, E. M. Sharpe, should appear in the list, but I did not catch any to-day. A little while ago I saw its larva there, so it does exist in that same locality.

"*Acraea alciope*, Hew. You will see that *A. alciope* does not figure. I saw *none* in this locality, though it had appeared again in the more sunny 'jungle.' It appears not to like *too* dense forest.

"*Precis rauana*, Grose-Smith. This is the first time I have met this species, and I was delighted to see what a good mimic it is on the wing—though I could see it *was* a mimic before I caught it."

Concerning the captures on Dec. 10, Dr. Carpenter had written, on this date :—

"It has been no use collecting for the last two or three months—in fact last Sunday was the first time I had been out for a long time, and I thought it would be good because we had had a good deal of rain in the month before.

"I do not think *Planema tellus* is uncommon : at any rate I send a fair number of specimens now, and have seen what I think to be others, for I am now beginning to be able to differentiate Planemas from Pseudacraeas by their general appearance and 'manners.'

"To-day (Sunday, Dec. 10th) I went to the same place in the forest, and got a few more specimens. There were not so many things about, but oh! I missed *heaps!*—a female *Ps. hobleyi* which appeared to be brownish instead of black and

white; lots of male *hobleyi*, *Pl. macarista* or *poggei*, and what I believed to be intermediate Pseudacraeas! Still, I send more *Pl. tellus* and *Ps. terra*. I said last Sunday I had seen no *A. alciope* in the forest. I saw two males to-day, and caught one, and *believe* I saw a female: anyhow, it is an addition to the list. I got another poor *Pr. rauana* to-day, and some more *Planema arenaria*, which I had not sent before Dec. 3."

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The following extract from the same letter of Dec. 10 referred to the four wings of a male *Acraea orina*, Hew. The detached wings were exhibited by Professor Poulton, together with the left forewing of *Euralia anthedon*, Doubl., found on the ground by Dr. Carpenter on Dec. 17.

"I found some wings of a red *Acraea* neatly clipped off lying together on a leaf, and a bird-dropping beside, as if a bird had dropped both! I send the wings. It is a curious thing that out of 40–50 bee-eaters (of three species) I have shot, to see if *Glossina* could be found in their stomachs, never a single one has eaten a Lepidopteron! They seem to live, here, entirely on Dragonflies and Hymenoptera. True, I have shot most of them on the shore, and not in the forest where they are high up out of reach; but I suppose the same ones frequent both shore and forest. It is rather curious they will eat the *hugest* dragonflies—larger than the big brown chap at home!"

The following extracts were from the letter dated Dec. 17, describing the last of these three days' captures:—

"*Dec.* 17. To-day (Sunday) I had my last collecting in Damba forest, with satisfactory results. There were great numbers of the pale *Planema arenaria*, of which I send a number. Curiously enough, on my way to the forest, I saw one in the 'jungle,' where I have never seen it before. You will see a very beautiful specimen of the dark *Pseudacraea obscura*. *On the wing*, this *Pseudacraea* far more closely resembles the pale *Pl. arenaria* (of which there were swarms to-day) than it does the darker *Pl. paragea*. Both *arenaria* and *obscura* have rather a translucent, pale effect (the little yellow on the *Pseudacraea* shows up very plainly); whereas in

Pl. paragea the yellow doesn't show, and it has just a sooty appearance. The flight of the *Pseudacraea* is also much more like that of *arenaria* than *paragea*, which is *very* feeble. Still, one must admit that the detailed marking in the cadaver (especially the basal red triangle) is much closer to *paragea*, although on the wing the likeness is the other way. I got another *A. alciope* to-day—a male—I haven't seen a female, but the forest is most certainly not the ideal place for it. The *Ps. terra* I was trying to get ova from escaped one day, so now
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I must wait till I get to Sesse. I leave here in a few days—spend a week at Entebbe at Xmas—and then resume my solitary island life, which suits me well!"

Dr. Carpenter's captures in Damba Island, exhibited to the Meeting by Professor Poulton, are tabulated below:—

Dates in 1911.	*Planema tellus platyxantha*, Jord.	*Pseudacraea terra*, Neave.	*Planema poggei nelsoni*, Grose-Smith.	*Pseudacraea hobleyi*, Neave.	*Acraea alciope*, Hew.	*Precis rauana*, Grose-Smith.	*Planema epaea paragea*, Grose-Smith.	*Pseudacraea obscura*, Neave.	*Planema arenaria*, E. M. Sharpe.
Dec. 3	2 ♂	1 ♂ 3 ♀: first with pale, second with white sub-apical bar to f.w.: the second with clear trace of brown triangle at base of h.w. under side. Third ♀ has the upper surface pattern of the ♂ *A. alciope*. Markings are the pale fulvous of *terra*. Pattern of h.w. that of *terra*, of f.w. combined *terra* and ♂ *hobleyi*. On under side the white f.w. bar of ♀ *hobleyi* and the umber basal triangle of h.w. are distinct, the latter remarkably so.*	2 ♂	1 ♂ 3 ♀: one with the colour and to a large extent the pattern of the male.		1 ♀	4 ♂	1 ♂: the f.w. sub-apical pale bar distinct: the h.w. basal triangle faintly indicated on under side.	1 ♂ 2 ♀

* K. Grünberg, writing on the Lepidoptera of the Sesse Islands in the Victoria Nyanza, describes a male of this obviously intermediate form as *Pseudacraea impleta*. In the same paper (Sitzungsber. d. Ges. Naturf. Freunde, Nr. 4, 1910) *Planema macarista*, E. M. Sharpe, is redescribed as *vendita*, and *Pseudacraea hobleyi*, Neave, identified as *Ps. togoensis*, Bartel.—E. B. P.

Dates in 1911.	*Planema tellus platyxantha*, Jord.	*Pseudacraea terra*, Neave.	*Planema poggei nelsoni*, Grose-Smith.	*Pseudacraea hobleyi*, Neave.	*Acraea alciope*, Hew.	*Precis rauana*, Grose-Smith.	*Planema epaea paragea*, Grose-Smith.	*Pseudacraea obscura*, Neave.	*Planema arenaria*, E. M. Sharpe.
Dec. 10	3 ♂	2 ♀: one with the umber triangle nearly equal to that of the specimen last mentioned.			1 ♂	1 ♀		1 ♀, similar to the above ♂.	2 ♂
Dec. 17	2 ♂	1 ♂ 3 ♀: one with very pale nearly white f.w. bar.		2 ♂ 1 ♀	2 ♂	2 ♀	1 ♀	2 ♂: one with the umber triangle remarkably distinct and deeply tinted.	5 ♂ 5 ♀
Totals	7 ♂	2 ♂ 8 ♀	2 ♂	3 ♂ 4 ♀	3 ♂	4 ♀	4 ♂ 1 ♀	3 ♂ 1 ♀	8 ♂ 7 ♀

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Professor POULTON pointed out that the specimens captured on Dec. 3, 10, and 17 confirmed the conclusions derived from a study of Dr. Carpenter's earlier captures in the same island (Proc. Ent. Soc., 1911, pp. xci-xcv). Although Dr. Carpenter had found that the *Planema* models were more abundant in the central forest area of Damba Island, yet even here all except *Planema paragea* were outnumbered in his collection by the respective mimetic forms of *Pseudacraea*. The proportions of these mimetic forms differed, as they did in the jungle, from those of the mainland only twenty miles away; while on the island, in the forest as well as in the jungle, transitional forms were far more numerous and also more truly intermediate than on the mainland. It was also noteworthy that out of four female *Ps. hobleyi* one should have borne the colouring of the male. The examples of *Pl. paragea* were all dark forms with the pale markings greatly reduced.

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Wednesday, March 20th, 1912.

Exhibitions.

A COLEOPTERON NEW TO BRITAIN.—Commander J. J. WALKER exhibited specimens of *Claviger longicornis*, Müll. (with *C. testaceus*, Preyssl., for comparison), a species of Coleoptera new to the British list. They were taken under stones near Kirtlington, Oxfordshire, in May, 1906, and April, 1907, in nests of a small black ant of a species not determined, but suggested by Mr. Donisthorpe to be possibly *Lasius umbratus*, Nye.

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LEPIDOPTERA WITH THE "NEPTIS" PATTERN, COLLECTED BY C. A. WIGGINS NEAR ENTEBBE IN 1909.—Professor POULTON exhibited 120 of the 130 insects in the following list—10 examples of *N. ophione* having been omitted for the sake of convenience. The exhibit had been arranged by Professor Poulton and Mr. C. A. Wiggins, during his visit to England in 1911. All the specimens had been captured in forests within a few miles of Entebbe, between May 23 and July 25, 1909. The captures were indiscriminate, so that the following list gives a fair idea of the true proportions in the period under review.

Neptidopsis ophione, Cram.	55
Neptis melicerta, Drury	30
,, *agatha*, Stoll	11
,, *metella*, Dbl.-Hew.	7
,, *nicomedes*, Hew., var. *quintilla*, Mab.	5
,, *nemetes*, Hew.	2
,, *saclava*, Boisd.	2
,, *nysiades*, Hew., ab. *continuata*, Holl.	2
,, *puella*, Auriv.	1
Deilemera leuconoe, Hopff.	14
,, *transitella*, Strand	1
Total	130

Professor POULTON said that the most astonishing thing

about the list was the predominance of the *Neptis*-like Euryteline, *N. ophione.* Considering the overwhelming numerical superiority over all the species of *Neptis* except *melicerta*—and this contributed but little over half the number of *ophione*—together with the existence in Hayti of an allied Euryteline with a somewhat similar pattern, Professor Poulton, in opposition to his former view (Trans. Ent. Soc., 1902, p. 468), was inclined to think that the patterns of African species of *Neptis* had been influenced by *Neptidopsis.* There was no doubt about the resemblance between the two genera on the wing. In support of this conclusion Professor Poulton exhibited a specimen of *ophione* taken by Mr. C. F. M. Swynnerton, April 18, 1911, on the outskirts of Chirinda Forest (3,800 ft.), in South-east Rhodesia. The "paper" bore the note "Taken for *N. saclava* on the wing. Mistake not discovered till in the net.—C. F. M. S." Mr. W. A. Lamborn had also written as follows on the same subject :—

"Oni Camp, *Sept.* 19, 1911.

"When writing of *Neptis* last week I might have said that I always find it difficult to distinguish large forms on the wing from *Neptidopsis*, and I still catch *Neptidopsis* under the impression that it is *Neptis*, from time to time. Both have the same floating and apparently leisurely flight, but it is quicker than one thinks, and I find both equally elusive and difficult to catch."

Comparing the patterns of the species in this combination from Entebbe, at first sight, *agatha* appeared to present the nearest approach to *ophione.* On the other hand, the markings of *agatha* differed in their purer white from those of *ophione*, which were faintly tinged with yellow, as in *saclava*, *nemetes*, and other species of *Neptis.* The two first-named species, especially *saclava*, also resembled *ophione* in the prominence of the black submarginal markings on both surfaces of the hind wings (see also above). Among the other species, *metella* was an evident mimic of *melicerta*, although an even closer one of those species of *Neptis*—unrepresented in the exhibit—in which the white stripe

running through the fore wing cell was continuous, and not, xxviii]
as in *melicerta*, divided at its distal extremity. There could be no reasonable doubt that *metella* was a mimic. To one unfamiliar with the species, it was a great surprise to see the under surface for the first time, and then to realise that the pattern of the upper side had given an entirely false impression of affinity. The three remaining species, *nicomedes*, *nysiades* ab. *continuata*, and *puella*, were closely similar, and would be indistinguishable upon the wing. The two Hypsid moths presented a rough approximation to the pattern of *agatha*.

NEPTIS SWYNNERTONI, A NEW SPECIES FROM S.E. RHODESIA. —Professor POULTON exhibited the male and female types, described below by Mr. Roland Trimen, F.R.S., together with a specimen captured in the garden at Chirinda (3,800 ft.) on March 28, 1911, by Mr. C. F. M. Swynnerton. The "paper" bore the note "continually settling on the ground.—C. F. M. S." Two specimens of the closely allied *N. incongrua*, Butler, captured by Rev. K. St. Aubyn Rogers on Feb. 16, 1911, at Chawia, British East Africa (5,000 ft.), were also exhibited, so that they might be compared with the new form from the south. The far narrower bar of the hind wing of *incongrua*, together with the much smaller size of the principal fore wing marking, at once served to distinguish the two forms.

"*Neptis swynnertoni*, sp. nov. A near ally of *N. incongrua*, Butl.* *Exp. al.* (♂) 1″ 8‴; (♀) 2″ 0½‴. *Brownish-black, with pure-white markings.*

"♂. *Fore wing*: Four minute spots in discoidal cell and three extra-cellular ones beyond its extremity, disposed as in *incongrua*; in the interrupted discal series of spots of unequal size—the first (minute subcostal) spot is wanting, the second is smaller and narrower, but the third larger and rounder than in *incongrua*; the fourth and fifth are very much

* Proc. Zool. Soc. Lond., 1896, p. 112, pl. VI, f. 2 (♀), and p. 826. This species was originally described from Nyassaland (♂♂) examples, but has since been found in British East Africa, two examples in the Hope Department having been taken by Rev. K. St. A. Rogers at Taita and Tuso (Kikuyu Co.) respectively (see also above).—R. T.

enlarged and confluent into a single conspicuous oblique elongate marking bisected by second median nervule; the [xxix sixth is wanting; and the seventh (on inner margin) is very much smaller and not so sharply defined. *Hind wing*: median band considerably broader—especially in its median part—its inner edge much nearer to base, and curved instead of almost straight, and its first (subcostal) spot wanting. Cilia in both wings white between nervules. UNDERSIDE.—Warm ferruginous-brown, of a redder tint than in *incongrua*, with the fuscous neuration and linear internervular streaks more pronounced; white markings as on upperside, but discocellular and subcostal spots larger in the fore wing, where the inner marginal subcellular area is shining grey, much more glossy than in *incongrua*.

"♀. Like ♂, but with all white markings larger, and the first spot of discal series—subcostal, small, and sublinear in fore wing, but of moderate size and conspicuous in hind wing—present as in *incongrua*. UNDERSIDE.—Ground-colour paler and brighter than in ♂, with an ochreous-yellow tinge; white markings as on upperside.

"The differences pointed out, and especially the large oblique medio-discal single marking formed in the fore wing by the enlargement and complete union of the two largest spots of the discal series, and the much broader and somewhat unevenly curved (instead of straight) band in the hind wing, give this form a thoroughly distinct aspect from that of *N. incongrua*, and to a considerable extent approximate it in pattern, as far as the upperside is concerned, to *N. marpessa*, Hopff. [= *saclava*, Boisd.], a congener of very wide Ethiopian range; but the similarity does not extend to the hind-marginal areas, which in *swynnertoni* (as in *incongrua*) are of the simple unvaried black of the ground-colour, but in *marpessa* are marked with a series of darker spots succeeded by two series of indistinct whitish lunules. As regards the underside, *swynnertoni* and *incongrua* differ widely both from *marpessa* and from the rather numerous African group represented by *N. agatha*, Cram., in the complete want (except in the case of the minute discocellular and subcostal spots of the

fore wing) of the numerous and elaborate minor paler and darker markings, and also in the rufous—or ferruginous—ochreous ground-colour; in both which respects, but especially

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in the latter, the two forms under notice, together with *N. exaleuca*, Karsch,* from Camaroon, and *N. woodwardi*, E. M. Sharpe,† from British East Africa, constitute a section apart from the other known Ethiopian ones, and approaching the group represented by the well-known Palaearctic species *N. lucilla*, Fab., ranging from Central Europe to Japan. It is remarkable that of these four forms, the extreme West African species, *N. exaleuca*, is, in the shape, disposition, and longitudinal extension of the markings, more like than any of the others to *N. lucilla.*

"The ♂ and ♀ of the new form here described were presented to the Hope Department by Mr. G. A. K. Marshall, who kindly informs me that both were taken—the ♀ by himself, and the ♂ by Mr. C. F. M. Swynnerton—in a remarkable isolated patch of heavy forest on the top of Mt. Chirinda (about 4,500 ft.), in the Melsetter District (formerly known as 'Gaza-land') in S.E. Rhodesia, situated quite close to the Portuguese border and about 150 miles by road south of Umtali. The ♂ was captured in March, and the ♀ on 18th October, 1905.‡

"It is a pleasure to associate with this interesting new form the name of Mr. Swynnerton, a naturalist who is a fellow-worker with Mr. Marshall in the richly productive region of Rhodesia.

"There is an obvious similarity between the narrow-banded

* Berl. Ent. Zeit., xxxix, p. 10, f. 5 (1894).

† Ann. and Mag. N. Hist. (7), iii, p. 243 (1899).

‡ Since the above was written the Hope Department has received from Mr. Swynnerton 3 ♂ ♂ and 2 ♀ ♀, taken in the same locality, but at a lower elevation, viz. 3,800 ft. The dates of capture of the ♂ ♂ are noted as respectively 1st to 6th March, 5th April, and 10th April, 1907, and of the ♀ ♀ respectively as 25th March and 13th April, 1907. These additional examples of both sexes agree very closely on both surfaces of the wings with the individuals above described—the only noticeable difference being in the smaller size of the inner-marginal white spot on the upperside of the fore wings. As regards size, however, the three ♂ ♂ have a rather larger expanse of wings, viz. 1″9–10½‴, and one of the ♀ ♀ a rather smaller expanse, viz. 1″ 11½‴.—R. T.

N. incongrua and the common *Eurytela hiarbas*, Drury,* a [xxxi Nymphaline of a group not remote from that represented by the genus *Neptis*. *E. hiarbas* has a very wide Ethiopian range; and, as I have noted in 'South-African Butterflies' (I, pp. 260 and 270), it and the two commoner species of *Neptis* occurring in the same districts of South Africa, have much the same flight and habits, hovering rather slowly about the lower trees and shrubs, and often settling—the *Eurytela* being more partial to the stems and the *Neptis* to the leaves. I also called attention (*op. cit.*, p. 258) to the much closer resemblance existing between the Tropical-African *Eurytela* (*Neptidopsis*) *ophione*, Cram., and *Neptis melicerta*, Drury; † and in view of the mimetic relations which probably obtain between the two genera, it is interesting to bear in mind that Mr. Marshall some years ago found some evidence of the distastefulness of the conspicuous *N. agatha*. ‡

R. Trimen."

Two African Species of the Danaine genus Tirumala (Melinda) as Models, and one as a Mimic.—Professor Poulton exhibited *T. formosa*, Godman, and its mimic *Papilio rex*, Oberth., from the Kikuyu Escarpment, near Nairobi, British East Africa; the same Danaine, and the transitional *Papilio commixta*, Auriv., from Nyangori, at the N.E. corner of the Victoria Nyanza; *T. mercedonia*, Karsch, and *Papilio mimeticus*, Rothsch., from Buddu on the W. shore of the lake; and *T. morgeni*, Honrath, with three

* This resemblance was pointed out by Rev. K. St. Aubyn Rogers in Trans. Ent. Soc., 1908, p. 507. It is worthy of remark that the eastern and southern *hiarbas* bear a much narrower white bar than the western. Although the Entebbe specimens are western in character, as in so many other species, the forms of *hiarbas* from the parts of British East Africa where *Neptis incongrua* was taken by Mr. St. Aubyn Rogers, are thoroughly eastern in the narrowness of the bar. Chirinda is remarkable in the possession of a local form of *hiarbas* in which the bar is again broader, approaching, although without equalling, the western type. *N. swynnertoni* is, at the same time, distinguished from *N. incongrua* by its broader white markings. The western affinity of other Chirinda forms has been observed by Mr. G. A. K. Marshall.—E. B. P.

† See, however, p. xxvii, where other species of *Neptis* are associated with *Neptidopsis*. The stripe running through the fore wing cell of *melicerta* appears to separate its pattern from that of *ophione*.—E. B. P.

‡ Trans. Ent. Soc. Lond., 1902, pp. 384, 386, 387.

of its *Amauris* models—*psyttalea*, Plötz, *hecate*, Butler, and an undetermined species, probably new, from the Cameroons. The specimens of *formosa*, *mercedonia*, and their models were those figured in Plates XI and XII accompanying Mr. S. A. Neave's paper in Ent. Soc. Trans., 1906, p. 207, and it was
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explained that, in the Hope Department, figured specimens illustrating the problems of bionomics were as far as possible always arranged side by side with copies of the respective plates. Professor Poulton said that, although the examples were well known, he had ventured to exhibit them, because the bionomic history of the three African species of the Oriental genus *Tirumala*, had never been so completely illustrated as in the drawer which he had brought to the meeting. There was something arresting in the sight of the actual species with their mimics and models, which was inevitably lost in descriptions and figures, however good. He drew attention to the fact that the deep reddish-brown colour of *mercedonia* was preserved, but little darkened, on that part of the under surface of the fore wing of *morgeni* which is covered by the hind wing in the attitude of rest, although elsewhere, on all visible parts of both surfaces, the tint had so far deepened as to present the closest likeness to the *Amauris* models. The pattern of the undetermined species of *Amauris* was more closely resembled than that of any other, although, in the form of the fore wings, *hecate* appeared to be the principal model. Professor Poulton pointed out that *Tirumala* passed from the condition of a model to that of a mimic at the point where it had left its original country furthest behind, and had penetrated most deeply into the area where the black and white species of *Amauris* were dominant.

A LARGE LEPIDOPTEROUS PUPA, PROBABLY LYCAENID, FOUND IN THE LEAF-NEST OF OECOPHYLLA, IN THE LAGOS DISTRICT.—Professor POULTON exhibited the pupal shell and the dead pupa referred to by Mr. W. A. Lamborn in the following note upon the tree-ant *Oecophylla smaragdina*, F., race *longinoda*, Latr. Both pupae, which were evidently of the same species, were attached to the leaf by an expanded suckerlike

base, similar to that of a much smaller pupa found in March, 1910, by Mr. Lamborn on the under side of a leaf 3 ft. from the ground, in the forest, $1\frac{1}{2}$ miles E. of Oni. This pupa produced, on March 11, 1910, a male *Argiolaus*, of which the species has not as yet been identified. This specimen and its pupal shell were also exhibited.

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"Oni Camp, *Feb.* 10, 1912.

"I have seen the ants using their larvae to weave silk in the manner described by Mr. H. N. Ridley, F.R.S., at Singapore (1890). They grip them dorsally and carry them to and fro, applying the larval mouth-parts to various points to fix the silk.

"When slightly alarmed these ants quiver violently so as to produce a rustling sound on leaves, and when still more alarmed the abdomen is uplifted and a drop of fluid is ejected to a distance of 5 or 6 inches.

"12/2/12.

"The ants are not thriving in captivity, and, as many of their larvae have died, I decided to 'board out' my Lepidopterous larvae all in one large nest. On opening one up last night, I found remains of a pupal shell and one large pupa dead—undoubtedly Lycaenid I should think from its resemblance to one sent last year. I am, however, puzzled on account of its large size; for I do not call to mind any Lycaenids large enough to correspond with the pupa, and if the larvae in my possession are of the same species, they cannot be a quarter grown. I send this dead pupa. The silk at the edge of the leaf bound it to the ants' nest."

The larvae referred to above were found by Mr. Lamborn in the leaf-nests of *Oecophylla*. Their form and habits were very remarkable, and Professor Poulton hoped to bring Mr. Lamborn's account before the Society when the imagines have been bred and identified.

THE SLUGGISHNESS OF TWO W. AFRICAN LYCAENIDAE OF THE GENERA EPITOLA AND HEWITSONIA.—Professor POULTON exhibited the three largest *Lycaenidae* captured by Mr. W. A. Lamborn, and suggested that the undetermined pupae in the

nest of *Oecophylla* might possibly belong to one of them. He pointed out, however, that all three were placed among the *Lipteninae*, while the problematical pupa bore much resemblance to a smaller one which produced an imago of the genus *Argiolaus*, belonging to the *Lycaeninae*. The three large species were *Epitola honorius*, F., male and female, *E. posthumus*, F., male, and *Hewitsonia boisduvali*, Hew., male and female. xxxiv]
Mr. Lamborn's notes on the two females showed a remarkable degree of sluggishness.

Epitola honorius, F., female. "Observed 5 p.m. Jan. 18, 1912, feeding on secretion of Homoptera on green stem near Oni clearing; seen again at same spot on Jan. 19, about 8 a.m. and 3.30 p.m., and at the same hours on Jan. 20 and 21. Captured 3.30 p.m. Jan. 21."

Hewitsonia boisduvali, Hew., female. "This particular insect observed on twig, 1 mile E. of Oni, Oct. 21, 1911, feeding. It was seen each day in precisely the same position up to Oct. 26, when I took it. It was identified by the damage to the hind wings. The twig on which it was feeding bore a number of Homopterous insects, most of which fell off when I took the butterfly, but two remain on the twig now sent."

The twig, still bearing the two Homoptera, was exhibited with the butterflies. The specimen of *honorius* was perfect, while both hind wings of *boisduvali* were symmetrically torn. It was evident that the closed wings had been seized at the anal angle, and a wide and deep notch, ending in a narrow chink, cut in each of them. The form of the chink seemed to be inexplicable except on the supposition that the injury had been inflicted by the beak of a bird.

The remarkable sluggishness of these immense Lycaenids suggested strongly that they were specially protected, and that the under surface of *honorius*—beautifully mimetic of *Planema*—was to be explained on the Müllerian hypothesis. The same conclusion was supported by the extraordinary under surface of *H. boisduvali*, and by the position of the butterflies on twigs and stems. Although not specially referred to in these cases, Mr. Lamborn had frequently spoken

of the striking conspicuousness of the *Lipteninae* when following their characteristic habit of feeding—probably always on the secretions of Homoptera—in an exposed position on twigs, etc. Professor Poulton had suggested that the *Lipteninae* were a specially protected group in Trans. Ent. Soc., 1902, p. 500.

AMAURIS EGIALEA STROKING THE BRANDS OF THE HIND WINGS WITH ITS ANAL TUFTS.—Professor POULTON exhibited a male

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Am. egialea, Cram., recently received from Mr. W. A. Lamborn. The "paper" enclosing the specimen bore the following note:—

"8 a.m. Half mile [from Oni clearing]; Jan. 30, 1912. Observed flying up and down. It then settled on upper surface of leaf and started to pass its brushes to and fro over its scent-patches, exactly as *Amauris niavius* did. Wings were rather over-flexed."

The latter statement was illustrated by a diagrammatic section which showed that the hind or outer margins of both wings were in contact with the surface of the leaf and thus below the level of the body. The observation was a most interesting confirmation of the conclusions to be inferred from Mr. Lamborn's earlier account of the behaviour of *Am. niavius*, L. (Proc. Ent. Soc., 1911, pp. xlvi, xlvii). Together with Mr. Lamborn's specimen, was exhibited a male of *Am. egialea* in which the brands of both hind wings had been entirely eaten out by ants, and a male of *Am. niavius* in which the right brand had been partially eaten. The injury was probably inflicted on the dead specimens by house ants. The *egialea* had been previously exhibited to the Society (Proceedings, 1907, p. x), but in view of this recent observation it was thought well to show it again.

These observations on the relationship between the anal brushes of male *Danainae* and the brands on their hind wings, were confirmatory of Fritz Müller's remarkable inference, published in the year 1877 ("Butterfly-hunting in many Lands." G. B. Longstaff, 1912, p. 619).

Dr. F. A. DIXEY said that among Professor Poulton's series of exhibits, that illustrating Dr. Lamborn's valuable observation on *Amauris egialea*, confirming as it did a previous obser-

vation by the same naturalist, had for him a special interest. It was well known that the scent-distributing apparatus in Rhopalocera took the form sometimes of specialised scales scattered broadcast over the surface of the wings, as in many Pierines and Lycaenids; sometimes of scales or hairs collected into definite patches, as in other Pierines and in the subfamily to which Dr. Lamborn's *Amauris* belonged. That the patch near the costa of the hind wing in *Colias edusa* was really a scent-patch, the speaker knew from personal obser-

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vation. In certain Pierines, as for instance *Catopsilia florella*, in addition to a *Colias*-like patch on the hind wing, there existed a tuft or fringe of hair-like scales near the inner edge of the fore wing. The close proximity of the latter to the former structure suggested that it might be used in some such way as the terminal tuft of the butterfly exhibited by Professor Poulton. The speaker had observed, as mentioned in his Presidential Address in 1910, that the scent-patches in Pierines were furnished with a special distribution of tracheae. The ultimate branches of these were difficult to trace, but in some instances they appeared to have an unmistakable connection with the sockets by which the scent-scales were articulated with the membrane of the wing. He thought at the time that he was the first to observe this peculiar connection of tracheae with the scent-patch, but had since found that he had been anticipated by Fritz Müller, who saw everything. Lt.-Col. Manders had also noticed it, though his observations on the point were at present unpublished. Dr. Dixey went on to say that he had put forward the suggestion that by the means of this tracheal supply, the products of the special secreting cells which had been observed (though not in actual connection with the scales of a scent-patch) by Weismann, Günther and others, might be propelled, as it were by a *vis a tergo*, into the scent-scale, and so, in a volatilised condition, into the outer air. In many cases of isolated scent-scales furnished with a proximal disc, an evident aperture existed in that part of the disc which was included in the socket. Through this the interior of the scale might be put into communication with the secretory apparatus lodged

in the membrane of the wing. In these cases the escape of the odour into the open air doubtless took place through the distal fimbriae with which scales of this type were usually provided; but Dr. Lamborn's observation suggested that the anal tufts acted as mechanical dispersers of an odour produced elsewhere, rather than as themselves directly connected with a secretory apparatus. The fact that in *Catopsilia* not only the *Colias*-like patch, but also the tuft or fringe, possessed a special supply of tracheal branches, seemed adverse to the idea that the fringe, in this instance, acted as a mere scent-sprinkler; that [xxxvii is, if the speaker's interpretation of the presence of tracheae were correct. It would be interesting, in view of Dr. Lamborn's observations, to know whether the anal tufts in *Amauris* were in connection with any secreting cells or other similar apparatus. For this purpose no information could be expected from dried specimens, and it would be most desirable to have fresh material treated with proper reagents on the spot, and so sent home in a condition fitted for microscopic examination.

Professor KELLOGG of California, who was present as a visitor, called attention, in connection with Dr. Dixey's remarks, to a paper by Mr. B. Thomas, of Cornell University, on the scent-glands in the wings of butterflies. In this paper Mr. Thomas described certain unicellular glands at the base of the androconia, which presumably could be interpreted as the producers of the scent-stuff given off by the androconia. Professor Kellogg added that in sections of wings made by himself he had noticed similar glands. It would be difficult to prove the actual continuity of the glands and scales, because of the peculiar mode of attachment of the scales to the wings, viz. by the insertion of a bulb-like expansion of the pedicel of the scale into a small pocket or cup in the membrane, the base of the scale and the membrane being quite discontinuous.

Dr. DIXEY, in thanking Professor Kellogg for his interesting observations, observed that the expansion of the pedicel was not really a bulb, but a disc.

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Wednesday, May 1st, 1912.

A VERY SCARCE EGYPTIAN PIERID.—Dr. G. B. LONGSTAFF exhibited a series of twelve specimens (five males and seven females) of the rare white butterfly, *Pinacopteryx doxo*, Godart (*venatus*, Butler), from the White Nile, Lat. 7° N. to 5° N. Dr. Dixey had informed him that he knew of but four specimens in collections, viz. Godart's type, a female, at Edinburgh, taken in "Africa," two females in the British Museum, both from the White Nile district, one of them being Butler's type of *venatus*, and Dr. Dixey's type of the male in the Hope Collection, also from the White Nile.

BIRDS AND INSECTS AT THE EDGE OF FIRE.—Dr. G. B. LONGSTAFF stated that large areas of the reeds and papyrus on the White Nile which constitute "the Sudd" are annually burned. Many birds are attracted to these fires, amongst others Mr. A. L. Butler of Khartum had especially noticed various species of swallow. Dr. Longstaff had, on more than one occasion, seen a number of kestrels in the smoke to the leeward of a fire, and had once watched for some time a pair of bee-eaters (*Merops nubicus*) perch within a few feet of a fire on the windward side. He saw them fight for a large Orthopterous

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insect which was driven out. This *Merops*, a beautiful copper—red bird with peacock-blue head and rump, was locally called the "fire-bird." The picture postcards exhibited showed four kites (*Milvus aegyptius*) hawking in the smoke.

Commander WALKER observed that he had seen the same thing occur in Australia, birds waiting for insects at the edge of a bush-fire and seizing them as they came out.

Dr. F. A. DIXEY congratulated Dr. Longstaff on his series of *P. doxo*, and observed that there was no doubt of the specific value of this insect, its scent-scales being quite distinctive.

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MIMICRY IN THE TROPICS CHIEFLY CHARACTERISTIC OF FOREST AREAS. THE BIRDS AND LIZARDS OF THE FOREST AND THE OPEN.—Professor POULTON said that he had long been struck, especially in the collections of butterflies received from

Uganda and British East Africa, with the immense development of mimicry in Lepidoptera from the forest as compared with the open country. It was, in fact, quite rare to find any examples of mimicry at all among the species that frequent the open. A few examples were known among the woodland species, while a large proportion both of individuals and of species were mimetic in the forests. It occurred to him that probably this difference was to be accounted for by the difference between the insect-eating animals in these two types of locality, lizards being probably the great vertebrate insect-eaters of the open, birds of the forest. When, there-

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fore, he found that Dr. R. C. L. Perkins, in his correspondence, suggested the same association between mimicry and forest areas, he determined to write at once to Africa and make special inquiry.

Mr. C. A. Wiggins of Entebbe replied, on Dec. 18, 1911, saying that he did not remember ever seeing a lizard in the true forest, but only in the glades, and that he had consulted with the Governor, Mr. F. J. Jackson, and found that their experience agreed. Mr. Jackson had kindly written the following letter on the subject:—

"Government House, Uganda,
"*Dec.* 18, 1911.

"Regarding lizards, I should say for every one you find in a forest, you find ten out in the open.

"Regarding insectivorous birds: the great majority, which include Shrikes (*Dryoscopus* and *Laniarius*), Trogons (*Hapaloderma*), Cuckoo-shrikes (*Campephaga* and *Graucalus*), Flycatchers (various), Warblers (various), Robin-chats (*Cossyphus*) Bulbuls (*Xenocichla* and *Andropadus*), are found in open forests, on the outer edge of thick forests, or forest glades. Most of the birds that are found in thick forest, *i. e.* well inside, frequent the tall tree-tops rather than the undergrowth. The Bee-eater (*Merops albicollis*), very common here, frequents tall trees in thick forests, rather than the open like most of the family.

"Exclusive of grain-eaters (Weavers, etc.), which feed

their young mostly on insects, there are very many more species, at least fifteen to one, probably more, of insectivorous birds found in the forest than there are in the open.

"FREDERICK J. JACKSON."

Mr. C. F. M. SWYNNERTON replied, December 22, 1911, describing the conditions in Chirinda forest, Gazaland, S.E. Rhodesia :—

"You ask whether birds are specially partial here to forest and lizards to open country.

"Our lizards *are* specially partial, apparently, to the sparse wooding of our open country, not but that there may be purely

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arboreal species in Chirinda (apart from *Rhampholion marshalli*) that have not yet come within my ken.

"Birds, however, are abundant in both types of country. Bird *species* are more plentiful in the open country, bird-population to the acre greater, probably, in the forest; but in this connection it must be remembered that the forest-birds have several 'upper storeys' to work, the forest trees running from 100 to 180, and exceptionally, 200 feet in height, against the 30 feet or so of the open woodlands,—and the view to take of this sort of thing must be a 'cubic' not a 'square' one! Again, owing to the greater density of the cover in the forest, the insect population is probably, taking the year round, relatively greater.

"I should imagine that there may be very little to choose between the forest and the veld in the matter of severity of selection. And that the veld-factors are capable of producing as good mimicry as the forest ones seems to be well shown in the *Danaida* combination.

"May not the phenomenon you refer to be, in part, dependent on the larval food-plant?

"Thus *Danaida's* food-plant here consists of various species of *Asclepias*, a genus that I have not found inside the forest. On the other hand the food-plant of *A. albimaculata* occurs only in forests or in dense thickets. I do not know those of our other *Danainae*, but, seeing that these belong to the same genus as *A. albimaculata*, it seems just possible that they may

feed on the same or some closely allied plant with, perhaps, the same habitat. That is to say, each of the 'models' of our main local associations is perhaps confined to a large extent to its particular type of country by the fact that its larval food-plant is found there and there only, and it is natural to suppose that its future mimics may have been determined on the same basis.

"It is also interesting to note, in this connection, that *Danaida* here never enters the forest, while the various species of *Amauris* constantly wander away from it. All our *Danainae* appear to be sun-loving insects, none are shade-loving as are *Aterica* and *Euphaedra*; obviously therefore it is not this consideration that causes *Amauris* to make the

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forest their head-quarters. *P. dardanus* also often wanders far afield:—one of the best places I know for it is a *Bougainvillia* bush, a good 1,200 yards from the forest—and it is interesting that it can do this without entirely losing the protection of its *Amauris* models while at the same time invoking, in the person of its *trophonius* female, that of the dominant Danaine of the territory it is invading."

THE POWER OF SIGHT IN BIRDS.—Professor POULTON said that he had come across a few observations which supported the conclusion that birds possessed the extraordinarily acute and far-reaching vision required by the Batesian and Müllerian theories of Mimicry.

1. The distant appreciation of the colour of small insects appeared to be shown by—"An Experimental Investigation on the Range of Flight of Flies" by Dr. Copeman, Mr. Howlett and Mr. Merriman (Report Loc. Gov. Bd. on Public Health and Medical Subjects: New Ser., No. 53. Further Reports on Flies (No. 4), 1911, p. 8). In these experiments, conducted in 1910 at Postwick, about five miles east of Norwich, flies were liberated after being marked with various colours so that they could afterwards be identified. Yellow chalk was found to give the most satisfactory results, and under favourable circumstances remained perfectly recognisable for a week or, on occasion, for as long as ten days. As soon as these flies were liberated many of them were devoured by

swallows, and the authors remark "it is interesting from the biological point of view, that they should readily take flies of a brilliant canary-yellow colour such as they can never have seen before. A few of these coloured flies that happened to drop into the water were also seen to fall a prey to fish." Dr. S. Monckton Copeman, F.R.S., had kindly sent a few further details concerning the behaviour of the swallows:—

"Local Government Board, Whitehall, S.W.,
"*February* 9, 1912.

"The swallows seemed to know when we were going to let loose the coloured flies; for although on our arrival there might not be a swallow to be seen over the river, no sooner had we let loose one lot of flies than there were usually a number to be seen, flying up and down in front of the
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wharf-staging from which we dispatched our flies. When the second lot was loosed the swallows at once proceeded to retrieve the flies while the latter were crossing the river in various directions;—the swallows never seeming to pause, but retrieving the flies unerringly while themselves in full flight."

These interesting experiments showed the danger of a conspicuous colour when associated with palatability.

2. The far-reaching distance of birds' vision was indicated in an article to which his attention had been called by Dr. F. G. Penrose:—"Hawk-catching in Holland, I." in "Country Life" for August 7, 1909 (p. 185). The article described the ancient methods which are still practised at the Dutch village of Valkenswaard (Falcon's Heath). One important element was the use of a tethered great grey shrike to act as a sentinel. "Now as soon as any bird of prey appears—*even far beyond the ken of any human observer*—this sentinel shows evident signs of terror, which increase if the enemy should come nearer. Old Adrian Mollen, father of the great master of the art, used to say, that, by the gestures and sounds of alarm of the shrike, he could sometimes form a pretty correct guess as to the size and species of the hawk . . ." (p. 187). The words here printed in italics were good evidence of the great distance at which birds could recognise the details of form and movement.

3. The following observation was recorded by Professor Poulton :—" On July 29, 1910, at Wykeham House, Oxford, my daughter and I saw a flycatcher, sitting on the branch of an elm, rather over 30 ft. distant, make a dash after a specimen of *Tryphaena pronuba* that was flying inside a room towards and on to the inside of the window. We were standing inside the room and saw the bird dash itself against the glass within a few feet of us. The pair of small windows, the only ones in the room, are somewhat deeply recessed in the side of the house, and the observation offers convincing evidence of the power of a bird's sight in penetrating shadow at a distance."

4. The following observation, also made by Professor POULTON, shows that small birds will attack insects of great relative

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size :—" Towards the end of June 1910, I saw a small robin flying with what was evidently a heavy load across the path of the Parks Road, Oxford, from the elm-trees on the west towards the Parks railing on the east. Just outside the railing it put the load down and began to peck it. I came near gently, and saw that it had captured a specimen of *Smerinthus tiliae*, L. I watched the bird peck the moth to pieces and eat the whole of it, except the wings. The observation was made just after heavy rain, which may have caused the moth to flutter or fall, and thus to attract the bird's attention."

Mr. S. A. NEAVE said with reference to Professor Poulton's interesting remarks on the prevalence of insectivorous birds in Uganda, that he had recently had an instructive experience near Entebbe. On January 12, 1912, at Gabunga's, near Entebbe, he had watched a wagtail, most probably *Motacilla capensis*, catching butterflies on a small patch of damp sand in the bed of a forest stream. The bird was so tame that he stood within 3 or 4 yards of it. In less than half-an-hour this bird captured and ate 19 butterflies and failed to catch many others. The butterflies eaten were nearly all small *Lycaenidae*, including *Tarucus telicanus*, *Polyommatus baeticus*, *Azanus* spp., many individuals, *Lycaenesthes* spp. (2 individuals), *Uranothauma* (?) *poggei* (1 individual), and a single

Terias, probably *T. senegalensis.* The bird also seized, but rejected after tasting, a specimen of *Acraea pelasgius.* This individual, with one hind wing torn off, was subsequently procured. Except for the loss of the wing it appeared to be uninjured.

Mr. G. A. K. Marshall and Dr. G. B. Longstaff also spoke on the subject, the latter giving an account of a struggle he had witnessed between a bird and a large grasshopper, in which the latter was eventually successful.

Neptis and Neptidopsis in the Lagos District.—Referring to his recent communication (in these Proceedings 1912, p. xxvi) on the proportion of the species belonging to these two genera in the neighbourhood of Entebbe, Professor Poulton called attention to a statement received in a letter from Mr. W. A. Lamborn, dated March 22, 1912 :—"*Neptidopsis* would

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I am sure outnumber all the species of *Neptis* put together at any season. I have not taken any more because I thought I had probably sent enough."

Eurytela Hiarbas and E. Dryope.—Professor Poulton said that his friend Mr. Roland Trimen, F.R.S., had pointed out to him that Mr. Lamborn's results published in these Proceedings (1912, p. xviii) are "confirmatory of Miss Fountaine's experience in Natal, given in Trans. Ent. Soc. Lond., 1911, p. 59. She records that although she had bred both forms indiscriminately from every variety of the larva, she nevertheless found that 'the ova laid by *E. hiarbas* always produced *hiarbas,* whereas those of a *dryope* ♀ invariably produced *dryope.*'"

Paper.

The following Paper was read :—

"On the Colour-Groups of the Hawaiian Wasps," by Dr. R. C. L. Perkins, M.A., D.Sc., F.Z.S., F.E.S.

Prof. Poulton, in introducing the paper, said that Dr. R. C. L. Perkins had illuminated a problem of the most fundamental interest and importance for the student of evolution. His work was of equal interest to the follower of systematics and of bionomics.

Dr. Perkins had inferred that the 102 species of *Odynerus*' the only indigenous wasps of the islands, had been derived from the ancient immigration from some unknown country, of a single yellow-banded species, and from the much later but still very ancient immigration of a single dark Asiatic species allied to *O. nigripennis*, Holmgr. The latter became extremely dominant, but it found the islands already occupied and only produced a group of 4 allied species, as against the 3 genera, the important structural groups and the 98 species which Dr. Perkins recognised in the descendants of the original immigrant. All the species attacked the larvae of Lepidoptera, and the immigration of these must of course have preceded the advent of the earliest ancestor of *Odynerus*.

Dr. Perkins showed in his paper how the 102 species had formed Colour-groups in which the constituent members were associated quite independently of affinity. Thus the species [lvii of a genus, or of a definite Structure-group within the genus, were found in different Colour-groups in the different islands, and sometimes even within the limits of a single island.

Although the species of *Odynerus* were the dominant members, some of the Colour-groups also contained bees, of which the 53 species in the single genus *Nesoprosopis*, were traced to a probable single Asiatic immigrant, allied to *Prosopis kriechbaumeri*, Först; and Fossores (*Crabronidae*), of which the 18 species and 3 genera were believed to have arisen from a single Asiatic invader, allied to *Crabro vagus*, L. The main Colour-group also included Ichneumonids.

In illustration of the paper, Prof. Poulton exhibited the specimens referred to in the following letters written to him by Dr. Perkins, Nov. 2 and Nov. 4, 1911, but here combined. The Colour-groups were arranged in the order of the islands, from Kauai in the N.W. to Hawaii in the S.E. The authors' names had been added by Prof. Poulton.

" Herewith I am sending a small box of Hawaiian Hymenoptera, showing the main colour-effects.*

* Dr. Perkins wrote Nov. 13, 1911 :—" The characteristic appearance of the various groups is far more remarkable in masses of specimens, such as I have in my cabinet drawers, than in a few isolated specimens."

"Colour-group A [= II of Kauai in Dr. Perkins's memoir.] —Black, wings dark, blue reflections, two white or yellow bands, second always broad. The examples selected are :—

Odynerus kirbyi, Dalla Torre . . . . Kauai.
Nesodynerus vittativentris, Perkins . . . Kauai.

"All the Kauai species, *whether open country or forest insects*, belong to this group, excepting one or two apparently recent arrivals from other Hawaiian islands, which are only slightly different in structure and appearance from *Odynerus sandwichensis*, de Sauss., of Group D.

"Group A is not *exactly* represented on the other islands, but a sub-group of pale-banded species on Oahu approaches it, and it is curious that the insects so coloured on all the islands except Kauai belong to the lowlands (open), or to the open country above the forest line, or to open spaces in forest regions.

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"Kauai is remarkable for its distinctively marked species, practically all belonging to the one Colour-group.

"Colour-group B [= II of Oahu].—Black, peculiar shining fuscous wings, almost brassy, distinctive appearance in life, not blue. Examples :—

Odynerus dubiosus, Sm. . . . . . . Oahu.
Nesodynerus oblitus, Perkins . . . . Oahu.
Nesoprosopis pubescens, Perkins, var., with blue
iridescence. Rare . . . . . . Hawaii.

"Peculiar, as an extensive group, to Oahu. It is to be noted that *N. pubescens* is a unique case of dichromatism of the wings.*

"Colour-group C [= III of Oahu].—Sombre red markings, much appressed tomentum on body, *wings nearly clear hyaline.* Appearance very distinctive in life, having a peculiar fuscous look. Example :—

Odynerus oahuensis, Dalla Torre . . . . Oahu.

* Judging only from this limited number of examples it appears that the typical *N. pubescens* more closely resembles the *Odyneri* of Group B, and the blue-iridescent var., those of E. Furthermore the example of *N. fuscipennis*, from Oahu, in Group E, might be more suitably placed in B. Both this specimen and *pubescens* (typical) are rather clearly distinguishable by the "brassy" appearance of their wings from the other members of E.—E. B. P.

"All the species are *Odynerus* proper, but very diverse in structure, the little Colour-group of six species, all peculiar to Oahu, representing three very distinct *structural* groups. There is nothing like them in colour on any other island. I have taken all six at the same spot and time on one occasion, and generally three or four are flying together.

"Oahu is remarkable for the diversity of its Colour-groups, all being represented, except that the pale-banded forms are not quite like those of Kauai, and the *sandwichensis*, Group D, has become the distinct *dubiosus*, Group B, above.

"Colour-group D [= III of Maui, etc.].—Species very numerous and diverse in structure but all are *Odynerus*.

"Black, with red markings, wings dark, blue reflections. I have sent two examples:—

Odynerus petrobius, Perkins	Molokai.
Odynerus sandwichensis, de Sauss.	Maui.

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"The wings of the latter are not so blue in some species, but the colour is much deeper when they are folded.

"Molokai, Lanai, and Maui are rich in these red-marked forms with dark wings.

"Colour-group E [= I of all the islands except Kauai].—This, the most dominant Colour-group, is black, wings infuscate, with blue, purple or steely reflections. *To see the iridescence at its best the insects should not be looked at in the box over white paper*, but held in the hand and viewed from above and in front. The colour of the wings is always conspicuous in life in this group, *i. e.* when the insect is flying, but in some it is less apparent after death.

"For this group I have selected :—

"DIPLOPTERA (*Eumenidae*).

Odynerus montanus, Sm.	Oahu.
,, *nigripennis*, Holmgr.	Oahu.
Nesodynerus rudolphi, Dalla Torre	Oahu.
Odynerus molokaiensis, Perkins*	Molokai.

* This species is placed by Dr. Perkins in Group II of Molokai, Lanai and Maui (= IV of Oahu), but it certainly seems to fit extremely well

Pseudopterocheilus congruus, Sm.	Molokai.
Odynerus peles, Perkins	Hawaii.
,, *heterochromus*, Perkins	Hawaii.

"FOSSORES (*Crabronidae*).

Hylocrabro tumidoventris, Perkins . . .	Hawaii.
var. *leucognathus*, Perkins . . .	
Xenocrabro atripennis, Perkins	Hawaii.
Nesocrabro rubrocaudatus, Blackb. and Cam. .	Hawaii.

"ANTHOPHILA (*Prosopidae*).

Nesoprosopis fuscipennis, Perkins	Oahu.
,, *caeruleipennis*, Perkins . . .	Molokai.
,, *pubescens*, Perkins, typical . .	Hawaii.
,, *setosifrons*, Perkins	Hawaii.

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"This large dominant Colour-group is not only exemplified by *Odynerus montanus*, but also by four other species, each of which represents a quite different Structure-group, and if there was any good classification of the heterogeneous mass forms called *Odynerus*, each would, in my opinion, represent a distinct genus. In addition to these and many other species the group contains *Nesodynerus rudolphi* and others, *Pseudopterocheilus congruus* and others, *Chelodynerus chelifer*, Perkins (not sent to you), various species of the three Fossorial genera, and of the Anthophilous genus *Nesoprosopis*—consequently representatives of nearly all the existing Hymenoptera of the Hawaiian islands.

"Hawaii appears to be tending to total blackness, owing to the predominance of this single Colour-group, the red of the red forms becoming duller or diminished, the bands of the banded forms more or less obsolete."

Prof. POULTON said that he had but few comments to make on Dr. Perkins's interesting and valuable paper, and, in fact, he felt considerable diffidence in making any suggestions at

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into Group E, sent for exhibition (Group E = I of Molokai, Oahu, etc.). The particular specimen of *O. molokaiensis* exhibited was captured in Maui (Wailuku, Sept. 1901), the species having reached that island, Dr. Perkins considers, about 1896.—E. B. P.

all on the work and conclusions of such a master of the Hawaiian fauna as the author had proved himself to be. Nevertheless he ventured to make a few remarks bearing upon the origin and present distribution of the Colour-groups in the islands and on one or two other points. Dr. Perkins had brought forward strong evidence for the conclusion that the first immigrant *Odynerus* was an ordinary-looking yellow-banded species—viz. one that had previously been an insignificant member of one of the largest and most widely distributed of the Aculeate combinations, containing many of the most formidable and dominant species, and bearing probably the simplest and most effective of warning patterns. The immigrant ancestor had behind it endless generations in the course of which its pattern had been rendered stable by selection ceaselessly exercised on some unknown continental area. Thus it was possible to understand the remarkable fact that so much of the original pattern should have survived or should still be revealed by reversion, at the close of a period long enough to have produced all the Eumenid Structure-groups in the islands except that associated with the later

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immigrant *O. nigripennis.* Prolonged isolation, in the Hawaiian islands, from all the other dominant bearers of the yellow-banded pattern also helped us to understand the ultimate loss of the original pattern in so many of the species.

The mention of this great dominant Aculeate pattern made it appropriate to refer at this point to a question raised by Dr. Perkins in his paper—" Why should Colour-groups be formed at all? Why is not the fact that an insect belongs to the Aculeates sufficient warning by itself?" It might be replied that the Aculeates themselves are probably avoided for different reasons and in different degrees, and that, for securing the advantages of Müllerian association, colour and pattern are probably the most easily recognised and remembered of all the characters that can be seen at a little distance when an insect is at rest. There was furthermore much, but not nearly enough, experimental evidence that insect-eating animals were greatly impressed by the *patterns*

mimetic of the Aculeates. The methods of mimetic resemblance were varied—sometimes the likeness was in pattern an not in movement, sometimes in movement and not in pattern, but in the most perfect examples there was likeness in both.

Returning to the history of the Colour-groups in the islands, we probably found, in the effects of occasional and accidental inter-island migration, an answer to Dr. Perkins's further difficulty based on the number of the Colour-groups, especially on Oahu. Whatever may happen in the vast complexity of a tropical continental area, we should certainly have expected, as Dr. Perkins maintains, the persistence or formation of single Müllerian Colour-groups on each of these small islands, although we ought to be prepared for possible exceptions in groups of specially associated species, such as the six forming Colour-group III (= C) on Oahu, all of which were captured at one time and in one spot by Dr. Perkins. Such special associations may have all the effect of geographical isolation in encouraging the growth of special warning patterns. Leaving such possible exceptions on one side, we should expect a single Colour-group on a single island, but we should not expect the same group to be formed independently in different islands,
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and the mixture of groups was probably to be explained by accidental transport from one island to another.

This was, in fact, Dr. Perkins's interpretation of the existence of two Colour-groups on the most isolated of all the islands, Kauai; for he remarks that "excepting two species (. . . probably recent derivations from similar forms on other islands) the Kauai wasps have become superficially all alike." Such complications are of course far more likely to occur in the central islands of the chain—nearer together and liable to receive immigrants from both directions.

The following was an attempt to reconstruct the history of the Colour-groups within the islands. It, in the main, followed Dr. Perkins's account, but included a few suggestions bearing on the mixture of the groups.

(1) The original yellow-banded pattern persisted at any rate in Oahu (the island nearest to Kauai), and probably throughout the islands, until after the Structure-groups had been

formed and Kauai had received the immigrants which have produced its dominant banded Colour-group II (= A).

(2) The black Group I (= E) then arose in Hawaii, perhaps in consequence of the arrival from Asia of the second immigrant ancestor, *O. nigripennis.* On the other hand, in the specimens sent by Dr. Perkins, the wings of some of the *Odyneri* were so much darker and more iridescent than those of the *nigripennis* as to throw some doubt upon the hypothesis that the latter had acted as the model. After the group was formed, Hawaii became a centre for the occasional accidental dispersal of black species to Maui and further north-westwards to other islands; or the spread of Group I may have followed the dispersal of the black-bodied, dark-winged *O. nigripennis*, which Dr. Perkins described as the most dominant and widespread species on all the islands except Kauai. That the black Group I is oldest on Hawaii was indicated by its almost complete dominance in that island.

(3) On Kauai, *O. nigripennis* became absorbed into the dominant Colour-group, giving rise to the yellow-banded *O. radula*, F. This species is as abundant on Kauai as *nigripennis* on the other islands, and Dr. Perkins suggests the possibility (among others) of a diaposematic relationship, the

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other Kauai species gaining the dark iridescent wings of *O. radula*, the latter gaining their yellow bands.

(4) The red-marked Group III (= D) arose in Lanai, Molokai or Maui, soon became common to all three, and, by accidental transport, was carried to all the other islands. The members that reached Hawaii have been nearly absorbed into its one dominant black group. The two allied species on Kauai are the result of an inter-island immigration so recent that neither of the Colour-groups has affected the other.

(5) In Oahu, nearest to Kauai, traces of the original banded pattern were more evident (in members of Colour-group II (= B), and especially in IV) than on any other island except Kauai. The red-marked Group III arose under the influence of immigrants from Molokai, etc., while in other species (in Group II) the same character has tended to disappear,

probably under the influence of the black Group I (= E) derived from Hawaii.

(6) It was not to be expected that the members of a Colour-group formed on any island, would, after reaching another island, always produce a group *exactly* like that in which they originated. The immigrants would be working upon different material, and would also be likely themselves to undergo changes of pattern. The peculiarity of the red-marked Group III (= C) on Oahu may perhaps be thus explained. Especially may changes be expected to occur in an appearance, like that of the wings, due to a uniform dark pigment combined with the "structural colours" of thin plates.

That there was undoubtedly a strong tendency to produce a single group on a single island was shown by the condition of Hawaii and Kauai, at opposite ends of the chain, and it was suggested that the same tendency existed in the other islands, but had been masked by the effect of accidental inter-island immigration.

Certain classes of facts established by Dr. Perkins, and described in his paper, were only intelligible on the hypothesis of mimetic approach due to selection by enemies attacking by the aid of sight.

(1) The persistence, in certain individuals belonging to the black Group I, of yellow bands on the under-surface where
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they could not be seen. The same phenomena were found independently in the *Eumenidae* and the *Crabronidae*. Dr. Perkins, with whom these observations had been discussed, entirely agreed that, as evidence, they were very important indeed. He also stated that the yellow bands of the Kauai Group II are clearly visible in flight.

(2) Species belonging to the same Structure-group, and therefore closely related, were distributed among different Colour-groups. In like manner the Kauai Crabros resembled its dominant, banded Eumenids, and the Hawaii Crabros its black Eumenids.

These facts fell into line with those which had been observed in the mimetic associations of the same and other groups of insects in other countries; and this was equally true

of the fact that the Hawaiian Colour-groups were especially characteristic of the forests. The difference between the development of mimetic patterns in Lepidoptera of the open country and those of the forest areas of Africa was extremely striking, and Professor Poulton had already been driven to the only hypothesis which Dr. Perkins could suggest as a possible explanation of the facts, viz. differences between the insect enemies in the two types of country (*see* pp. l–liii).

The only point in which his experience differed from that of Dr. Perkins was in the relative prevalence of variability and of mimicry in the two sexes of insects.

Dr. Perkins was by no means convinced of the validity of the Müllerian interpretation, and felt many difficulties, but, at any rate, he stated that he was unable to suggest any other explanation, and he had definitely abandoned the climatic solution, which many have found so alluring.

Prof. Poulton said, in conclusion, that he wished to make one remark on the bearing of the whole body of facts recorded in Dr. Perkins's memoir. He was aware that it was dangerous to limit the possibilities of future discovery, and to argue from the unknown to the non-existent. He realised that nearly every great discovery in Biology revealed something that lay close at hand although it was unseen. But, allowing for all this, he ventured to affirm that, if, in these little islands—closely examined as they had been for so long a

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period by so keen and discriminating a naturalist and one who had shown a life-long devotion to the Aculeates, not only as specimens, but as living beings—nothing except the Müllerian principle could be suggested as the cause of the Colour-groups, then it was far more reasonable to conclude that the insufficiency of the evidence was due to changed conditions brought about by man,* than to suppose that there existed in these restricted areas some set of causes hitherto unsuspected and unknown.

* Dr. Perkins describes the immense changes that have taken place in the bird fauna within his own memory, and argues that, if the Colour-groups were formed by the Müllerian principle, it was under conditions that do not now exist.

lxviii] **Wednesday, June 5th, 1912.**

Two uncommon Sudanese Butterflies.—Dr. G. B. Longstaff exhibited *Calopieris eulimene* and *Teracolus pleione*, and read the following notes :—

Both sexes of *Calopieris eulimene* were described by Klug in 1829, from specimens taken at Ambukôl by Dr. Hemprich and Dr. Ehrenberg. Kirby gives its habitat as Arabia, but Ambukôl is on the Upper Nile, about half-way between Dongola and Abû Hamed, in Lat. 18° N.

In 1896 Mr. A. J. Cholmley, who was attached to Theodore Bent's expedition to the Red Sea, took five specimens at Ambaia Erba, north of Suâkin.

In 1900 or 1901 a single example was taken by a member of the Hon. N. C. Rothschild's expedition at Shendi, between Berber and Khartûm.

These are the only records that I have come across.

In February 1909 I picked up a single specimen in the western outskirts of Khartûm, and a few days later took seven others at Soba, on the Blue Nile, about fourteen miles above Khartûm. These were all males.

In February of the present year I took between Soba and Khartûm six more, three of each sex, mostly in indifferent condition. I did not meet with it south of Lat. 15° 30′ N.

Meanwhile, during the past winter, Mrs. Waterfield had been taking it from time to time at Port Sûdân, on the Red Sea, getting altogether perhaps a dozen. At the end of
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February I myself visited Port Sûdân, and in the course of a week was fortunate enough to secure eighteen males and nine females. Unless I am greatly mistaken the larva should turn up on the desert Caper (*Capparis aphylla*, Roth.).

The purple gleam on the yellow apical spot, which adds so much to the beauty of the butterfly, is only present in the male.

It will be observed that the specimens from the Red Sea are larger and more strongly marked than those from the Blue Nile. The discal spot is in most cases larger, and there is more black about the apex. Moreover, the yellow nervures

on the under-side of the hind wings are edged with black, this black edging being often visible on the upper surface. Klug makes no mention of this black edging, which I am disposed to associate with the heavy rainfall at Port Sûdân a few weeks before my visit, whereas Khartûm was suffering from drought. Mrs. Waterfield wrote to me when I was at Khartûm saying that butterflies had been much more plentiful since the rain, and more strongly marked.

Teracolus pleione is another of Klug's species, the types coming from "Arabia Felix," whatever that geographical expression may mean.

Petherick took it on the White Nile, and Mr. W. S. L. Loat in 1901 took a female at Kâkâ on the same river in Lat. 10° 40′ N. In February last I myself took two females near the same village. Colonel Yerbury found it at Aden, apparently in some numbers. Colonel Swinhoe (Proc. Zool. Soc., Lond., 1884, p. 436), says: "Of this very rare species I have a series from Aden." However, Mrs. Waterfield looks upon it as one of the commonest butterflies in the Park, at Port Sûdân. This park is little more than a piece of the desert scrub which has been railed in. On and about certain shrubs, a species of *Cleome* (Nat. Ord. *Capparidaceae*), *T. pleione* was so plentiful that I repeatedly had several in my net at once. A few turned up north of the harbour near the shore, but I did not meet with it in the desert to the west or south of the town. It is evidently a far more local insect than its near ally *T. halimede*, Klug.

It should be noted that the females from the White Nile

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differ from those taken on the shore of the Red Sea by approximating in colour to the males.

Colonel Yerbury observed that the yellow ♀♀ of *Teracolus pleione* were much brighter at Aden than those now exhibited.

East African Asilids and Rhopalocera.—Mr. S. A. Neave exhibited some specimens of the Asilid genus *Hyperechia*, representing three, perhaps four, species, all taken during his recent tour in East Africa. He also showed for comparison four common species of *Xylocopa*, bees to which the flies bore a marked superficial resemblance. These flies were usually

found only in forested, or at least well-wooded localities, and usually settled on tree trunks, often high up on them, in contradistinction to many other *Asilidae* which usually settle on the ground. He thought that the great rarity of these insects in collections was due partly to their actual scarcity in nature, and partly to the fact that they were extremely difficult to capture on account of their wariness and powerful flight.

He also exhibited a remarkable new Nymphaline Butterfly, probably belonging to the genus *Pseudacraea*, taken on Mt. Mlanje, Nyasaland. He pointed out that it bore a marvellous superficial resemblance to *Amauris lobengula whytei*, Butler, the Danaine which occurred in the same place.

He further exhibited a number of unnamed *Lycaenidae*, principally from Uganda. Apart from the fact that many rare or unknown species were included amongst them, their chief interest was that they demonstrated the marked dominance of the Liptenine section of the *Lycaenidae* from that region, and thus accentuated the resemblance of the Uganda fauna to that of the Tropical West Coast of Africa.

Mr. S. A. Neave also referred to some interesting points, to which Prof. Poulton had called his attention, occurring amongst the butterflies recently collected by him in Eastern Uganda, particularly in the neighbourhood of Mount Elgon. The specimens of *Pseudacraea hobleyi* from this locality were remarkable for the fact that a large proportion of the females were coloured like the male, *i. e.* with an orange band in the fore wing instead of a white one, as in the typical form of the female common at Entebbe. He pointed out the extreme

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interest of this when coupled with the fact that one of the two *Planema* models, *P. macarista*, which has a black and white female, is not known to occur east of the River Nile, whereas the other, *P. poggei*, which has an orange band in both sexes, does so. It is true that in the present case no *Planema* of any species was actually taken during three days' collecting in a patch of forest on the Siroko River to the west of Mount Elgon, where the majority of the male-coloured females of *Pseudacraea hobleyi* were taken. At the same

time Mr. Neave had recorded *P. poggei* from the Tiriki Hills and Nyangori near Kisumu, in the C. A. Wiggins collection at Oxford, and had himself taken the same species on the *east* side of Elgon, and also in North Kavirondo, where it was not uncommon. Dr. Jordan had also been kind enough to inform him, through Prof. Poulton, that there are Kavirondo specimens of *P. poggei* in the Tring Museum, but no *P. macarista*.

The following are the details of the Uganda localities, the full particulars of the country further east on the East African side of the border not being available at the moment.

August 1, 2, 1911, Busia, near the Sio River (the boundary between British East Africa and Uganda)—

2 *Planema poggei*, 1 ♀ *Pseudacraea hobleyi* (male coloured).
1 ♂ " "

August 12–14, 1911, Siroko River, west of Mount Elgon—
16 ♂ *Pseudacraea hobleyi*
9 ♀ " " (male coloured)
5 ♀ " " (typical).

Prof. Poulton commented on the importance of the colour change of these Pseudacraeas in this locality, tending as they did to become monomorphic.

Dr. Longstaff drew attention to the difference between the fauna of this locality and that of the White Nile.

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Heredity in the female forms of Hypolimnas misippus.—In continuation of the breeding experiments referred to in the Proceedings, 1911, p. xliv, Prof. Poulton exhibited females of two families, reared in 1911, from female parents of the type form, by Rev. K. St. Aubyn Rogers, M.A., F.E.S. The first parent was captured at Rabai, near Mombasa, April 17: the emergence of the large family of nearly 200 butterflies took place while Mr. Rogers was away from home, and when he returned, on May 23rd, the great majority were irretrievably damaged. All the females were of the type form, and of these Mr. Rogers had sent the specimens which were in good condition, viz. the 16 exhibited to the meeting. At the same time it was to be noted that all 16

bore labels in Mr. Rogers's handwriting indicating emergence on May 16, 1911. In three of these the white patch on the hind wing upper surface, just beyond the cell, was distinct; in six it was slightly indicated; in two represented by scattered white scales. The patch was not borne by the parent. The second female parent was captured in the same locality on Nov. 29, 1911; the males were liberated, and the dates of emergence and forms of the females were shown in the following table, in which no mention is made of the white patch when represented only by scattered scales:—

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DATES OF EMERGENCE IN 1911.	*Misippus* FORM OF ♀.	*Inaria* FORM OF ♀.	♂
Dec. 22 .		1 [escaped]	3
,, 23 .	13 [12 specimens received] Patch distinct in 4, slight in 3	5 Patch very slight in 1	31
,, 24 .	6 Distinct in 2	5	13
,, 25 .	8 Distinct in 3, slight in 1	5 Slight in 1	16
,, 26 .	5 Slight in 1	2	10
,, 27 .	3 Distinct in 1		
,, 28 .	3		
Totals .	38	18	73

Two or three males died, but are put down for the dates on which they changed colour preparatory to emergence.

These experiments confirmed the conclusions drawn from Rev. St. Aubyn Rogers's earlier work and stated in the Proceedings of 1911, p. xliv, that *misippus* was dominant and *inaria* recessive, although the proportions of the last family were neither 1 : 1 nor 1 : 3, but, on the contrary, very nearly 1 : 2. It was possible, as Mr. L. Doncaster had suggested, that the female had paired with more than one male.

The white patch which so commonly appeared, represented a patch of variable size which seemed to be always present on the under surface of the hind wing of the female. This under surface marking again represented the central part of the broad white bar crossing the middle of the male hind wing with which also corresponded the white patch on the upper surface, as might be seen by holding the insect up to the light. The white patch of the female appeared therefore to represent a marking that was very ancestral in the genus *Hypolimnas* and common to many of its species, including the remarkable *H. dexithea* of Madagascar.

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The Tsetse-fly Glossina caliginea, Austen, rejected by a Monkey.—Prof. Poulton exhibited the fragments of a *Glossina* identified by Mr. E. E. Austen as a female of *G. caliginea*, Aust. The specimen had been bitten and rejected by a monkey under the circumstances described by Mr. W. A. Lamborn in the following paragraph written from Oni, March 24, 1912:—

"Good breezes are now blowing, and so this afternoon we ran across the lagoon in the sailing boat and had tea in one of the creeks. Two *Glossina* were rather a nuisance, and one settled on the leg of one of the men, who killed it with a sharp slap so that it fell into the bottom of the boat. I was too busy to pick it up just then, but the female Mona picked it up, smelt it and put it in her mouth. She took it out very shortly, pulled off one wing and then bit the insect in two. She dropped the thorax, but put the abdomen in her mouth. It was only kept there a few seconds, and then she took it out, smelt it, deposited it on the seat, and ran away. I send the specimen. The Mona is very fond of *Tabanidae*, and had caught and eaten several in the house before we went out."

Mr. Guy Marshall had suggested to Prof. Poulton that the presence of fresh blood in the fly may have been distasteful to the monkey.

Families of Butterflies bred by W. A. Lamborn in the Lagos District.—Prof. Poulton exhibited the following families, and referred to the strong light which was thrown by them upon different biological problems :—

1. *Salamis cacta*, F.—The Oriental Kallimas were well known to exhibit the most remarkable variation in the colours and patterns of the under surface. It was generally believed that these individual differences, which appeared in the broods of both wet and dry seasons, would be found in the butterflies raised from the eggs laid by a single female, but so far as Prof. Poulton was aware this conclusion had never been tested by breeding. It was therefore very satisfactory that Mr. Lamborn had succeeded in rearing from a batch of small larvae found upon the upper surface of a single leaf, a family of *S. cacta*, allied to *Kallima*, and showing the same kind of individual variation. The larvae were found in the forest
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two miles E. of Oni Camp, on October 5, 1910, and the whole cycle of development evidently lay well within the limits of the wet season, which extended from about April 25 to November 15, 1910. The position and uniform size of the larvae, together with the dates of emergence, showed that Mr. Lamborn was dealing with a company hatched from a single batch of eggs. The twenty-nine butterflies exhibited the most remarkable differences of under surface—differences which could be grouped in four main classes, according to the tint of the ground-colour and according to the presence or absence of a large white patch covering in great part the basal half of the hind wing. There was furthermore in all four classes great variation in the mottling and in the development of the oblique veining on the basal side of the midrib-like stripe The pattern of the upper surface was remarkably uniform, and there was no doubt that all the appearances presented by the under were procryptic, as in *Kallima*. The dates of emergence, sexes and main classes of the twenty-nine individuals were set forth in the table on the following page.

The table showed that the thirteen males emerged on the average rather earlier than the sixteen females, that the colour differences were unconnected with sex, that the two main classes were as nearly as possible equal, viz. fifteen purplish to fourteen greenish, but that the white patch was far more frequently associated with the purplish than with the greenish ground-colour—viz. seven out of fifteen to three out of fourteen.

DATES OF EMERGENCE IN 1910.	PURPLISH UNDER SURFACE.				GREENISH UNDER SURFACE.			
	With large white patch on H. W.		Without patch.		With large white patch on H. W.		Without patch.	
	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.
Oct. 27 .	1	2	4	2			5	2
„ 28 .	1	2		2	2	1		3
„ 29 .		1						1
Totals .	2	5	4	4	2	1	5	6

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2. *Hypolimnas* (*Euralia*) *anthedon*, Boisd., and *dubia*, Beauv.—The small family exhibited to the meeting had been bred by Mr. W. A. Lamborn from the eggs laid February 9, 1912, by a female *dubia*, with a pattern somewhat transitional towards that of *anthedon*. The parent, which was also exhibited, had been captured half a mile from Oni Camp on February 6, and died February 11. Of the seven offspring, three *dubia* and one *anthedon* emerged at about 11.30 a.m. March 8, having pupated March 2: one *dubia* and two *anthedon* emerged March 10. The proportion, as nearly as possible half and half, was most reasonably explained by supposing that the female parent was a heterozygote and the male a recessive (*anthedon*). The three *anthedon* offspring were all typical, while the four *dubia* were intermediate like the female parent. In order to appreciate the result it was necessary to state that the ordinary heterozygote of this species bore the pattern of the dominant *dubia*, and was not intermediate.

Further work was needed, but it appeared probable from the facts at present known that the intermediate pattern, which behaved in heredity just as a typical *dubia*, was not itself of composite origin, but rather a true intermediate which threw light on the origin of the dimorphism.

3. *Amauris psyttalea*, Plötz, and *A. bulbifera*, Grose-Smith. —Examples bred by Mr. Lamborn from two families of larvae were exhibited, and both sets showed the most perfect transition between these two so-called "species" which have only been separated because two spots in the fore wing of one are

connected by a bridge in the other. Both series showed a gradation from the complete bridge to its entire absence. One series consisted of four males and four females reared from eggs seen to be laid at 5 p.m. December 7, 1910, in an open space by a native village 1½ miles E. of Oni. The eggs hatched December 12, and four of the exhibited specimens pupated December 25, and emerged January 4, 1911; the other four on December 26 and January 5 respectively. The whole cycle fell well within the dry season, from about November 15, 1910, to March 15, 1911. The other series consisted of three males and one female bred from a company of larvae found

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August 14, 1911, in Oni clearing. One imago emerged August 30, three on August 31, and the cycle evidently fell well within the wet season, from about March 15 to December 8, 1911.

THE BREEDING OF EURYTELA HIARBAS, DRURY: A CORRECTION.—Prof. POULTON said that he had sent a proof of the Proceedings for 1912, pp. xviii, xix, to Mr. W. A. Lamborn, who had pointed out that *E. hiarbas* had been bred by him from scattered larvae and not, as stated, from a known female parent. Prof. Poulton wished to correct the mistake he had inadvertently made.

THE IRRITATING HAIRS OF THE MOTH ANAPHE INFRACTA, WALSINGHAM.—Prof. POULTON exhibited a specimen of the Eupterotid, or, as Aurivillius considers, the Notodontid moth *Anaphe infracta*, concerning which Mr. W. A. Lamborn had written from Oni Camp, April 22, 1912:—

"I cannot say when the common cocoon was formed other than it was in July, 1911. The moths undoubtedly possess urticating hairs. The female Mona was allowed to steal one. She smelt it, rubbed off the hairs and scales, then dropped it and in a few minutes was rubbing all four feet on the ground. I made some sympathising remarks with the result that she suddenly sprang on to my bare neck, and I have been troubled with skin irritation all the evening. I found too that an urticating line on my arm followed exactly where I allowed a moth to crawl up a few days ago. It came and settled there when I was reading."

Prof. Poulton said that Mr. A. H. Hamm had found hairs from the anal tuft of the exhibited specimen produced irritation on his hand and face. Mr. Eltringham had found that the hairs of the female but not of the male tuft were covered with minute excessively fine spicule-like teeth.

Mr. H. Eltringham contributed the following notes on this subject :—

In the first volume of "Lepidoptera," in "Allen's Naturalist's Library," there is a translation by Kirby of a paper by Piepers which originally appeared in the Proceedings of the Dutch Entomological Society. Kirby there states that his translation appeared in the Entomologist for November 1875, though I

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cannot find it in that publication. In the paper referred to, Piepers describes a small white moth which he refers to the genus *Scirpophaga*, alluding to it as one of the pests of S.W. Celebes, since, attracted by light it comes into houses, and frequently settles on the inhabitants. Wherever it touches the naked skin it leaves an intolerable itching. The author further states that this moth attaches to the walls of rooms masses of eggs covered with yellow down. This is the earliest reference I have been able to find to urticating hairs occurring in the perfect insect. I am indebted to my friend Commander Walker for kindly pointing it out to me. On hearing of Mr. Lamborn's discovery, or rather I should say of his monkey's discovery, I naturally thought of examining the moths *Porthesia similis* and *P. chrysorrhoea*. Reference is made to the urticating properties of these moths in Barrett's British Lepidoptera, where the author states that the irritation has been thought to arise from the long hair-like scales of the fore wing inner margin as well as from those of the anal tuft.

In the case of the larvae of these species the urticating properties are of course well known, and in order to appreciate the structure of the hairs in the moths I should first point out that in the case of the larva of *P. similis* there are two kinds of hairs, the first long and not very numerous, the second short, very minute, and exceedingly numerous. The long hairs are provided with irregularly placed, slightly curved spines. The small hairs are of a quite different and very

peculiar structure. They vary in length from about ·18 to ·08 of a millimetre; they are very finely tapered towards the end by which they are attached, and the outer end, which is much thicker, is furnished with three or four large sharp barbs, similar projections of gradually decreasing size being profusely arranged along the whole length of the hair, or spicule, as it may be termed. These spicule hairs, which in the case of the processionary caterpillars have been described by Judeich and Nitsche, occur in enormous numbers, and I believe that to them is mainly due the inflammation which ensues from contact with the larva.

Now in the female moth, *P. similis*, microscopic examination of the hairs in the anal tuft shows that there are present three
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kinds of hairs. First, long thick hairs, having a smooth and innocuous surface. These are most numerous on the peripheral portion of the tuft, in fact all the hairs here seem to be of the smooth kind, but they occur also in considerable numbers throughout.

Secondly, there are great masses of very fine hairs which for a portion only of their length are covered with irregular sharp jagged processes. A bundle of these hairs, when highly magnified, presents much the appearance of a tangle of brambles. These hairs are quite different from the large hairs of the larva. Also it is to be noted that it is the basal end of the hair which is spiny, so that when the moth has made a tuft over its eggs the spiny part will be uppermost, and so in the position to be first touched by an enemy. Thirdly, and this seems the most remarkable fact, there are amongst the two kinds of hairs already described, great numbers of little spicule hairs apparently precisely similar to those found in such profusion on the larva. One is at first tempted to suppose that these may in fact be derived from the larval skin in the cocoon, but unless the moth in emerging deliberately thrusts aside the pupal skin and brushes that of the larva with its tail, it seems difficult to understand how it can acquire them from any external source, and it therefore seems probable that the moth can grow these spicules just as the larva does. I am taking measures to find out how these

spicule hairs are acquired, but meanwhile there is no doubt that any small bird attempting to pick out the eggs from the tuft which protects them would first get a mouthful of some thousands of these irritating little objects.

The anal tuft of *P. chrysorrhoea* differs, in that there is in it a much larger number of smooth and inoffensive hairs, but as if to make up for the greater leaven of innocence, the long urticating hairs are covered with prickles over nearly their entire length, whilst the spicule hairs are lurking amongst them just as in *P. similis*. As one would expect, the analogous structure in the male moth contains neither spiny hairs nor spicules.

To return to *Anaphe infracta*, the urticating hairs of the female are of quite different structure to those in the two

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moths which I have described. They are of about three times the thickness of those in *similis* and *chrysorrhoea* and they appear to be covered with projections which may be described as resembling saw-teeth regularly arranged along their entire length.

There are no spicules so far as I have been able to discover. I may say that I am going into the whole matter more minutely and hope to have something more to say about it on a future occasion.

THE COCOONS OF THE AFRICAN LASIOCAMPID MOTH CHRYSOPSYCHE VARIA, WALK.—Professor POULTON exhibited the imagines and cocoons of *C. varia* sent to him by Dr. G. D. H. Carpenter from Damba Island, 20 miles south-east of Entebbe. The larval skin was still projecting from some of the cocoons, and showing its blue spots. The larvae had spun up November 12, 1911, and the moths emerged December 13.

Dr. CARPENTER had written, April 18, 1912, from Bugalla, one of the Sesse Islands:—

"The cocoons of Imago *D* 137 [*Chrysopsyche varia*] are particularly interesting. The larvae are gregarious, resting freely exposed on the tree trunk by day, at sunset going up in a procession to feed. When full-grown they are chocolate brown with blue patches and patches of glistening white short hairs—very conspicuous. The cocoon, when finished, has a hole at one end,

through which the larval skin is partly pushed out at pupation, and projects, showing the bright blue patches. Now as the moth *makes* a hole at the *other* end for its exit, the only explanation is that the aposematic larval skin is made use of to protect the pupa! I know of no other cocoon in which a hole is left especially for the extrusion of the larval skin. The cocoons are not especially exposed, in fact I had to search to find them: they were in a sheltered nook under fallen branches and amongst projecting roots. I left the larvae on the tree as they would not eat in confinement, but just wandered round and round the box in single file, head to tail, forming a complete ring, and looking very absurd! Evidently they wanted the stimulus of climbing up the tree to make them eat."

Professor POULTON said he had no doubt that Dr. Carpenter's interpretation was correct. It required a very
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definite adaptation of instinct to produce the result. The cocoon had a very dense appearance, but it would be satisfactory to examine it *before* the extrusion of the larval skin and to watch the larva when spinning. It was by no means uncommon for procryptic colouring and habits to be combined with an aposematic second line of defence. He suggested that the use of the old larval skin might be compared with the still more elaborate instinct described by Portchinsky in a species of *Lina* (*Melasoma*)—he believed *L. tremulae*, F. The larva of this Chrysomelid beetle, when disturbed, extruded a spherule of milk-white fluid at the aperture of each gland-duct opening on the skin, and when disturbance ceased, the fluid was again withdrawn into the body. Professor Poulton said that he had witnessed this procedure in the larva of a species of *Lina* at Lake Louise, in the Canadian Rockies, in the autumn of 1897, and had found it to be precisely as described by the Russian naturalist. Portchinsky stated that a store of the same fluid is contained in the old larval skin after pupation and that, when the pupa is irritated, it "sits up" and brings pressure to bear on the skin which still envelops its posterior segments. This pressure causes the fluid to appear at the old apertures, to be presently withdrawn by the recovery in the

shape of the skin when the pupa sits down again. Professor Poulton said that he owed the translation of this observation from the monograph of the distinguished Russian naturalist to the late Professor W. R. Morfill, of Oxford.

Dr. T. A. Chapman remarked that the hairs covering the eggs of *Porthetria dispar* are also urticating. He also observed that there are other species of moths which extrude the larval skin, but in these cases it was from flimsy cocoons. Mr. J. H. Durrant also gave instances of this fact.

The warning colours of the Hypsid moth "Callioratis" pactolicus, Butl., in all its stages.—Professor Poulton exhibited the larvae, pupae and imagines of *pactolicus*, sent by Dr. G. D. H. Carpenter. Two species belonging to the genus *Callioratis* had been recently recognised as *Geometridae*, and had carried off the genus into this family, leaving the true *Hypsidae*, *pactolicus* and its allies, at present without a generic

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name. The 2 black-and-white-ringed larvae and the 2 orange black-marked pupae has been collected on April 17, 1912, by Dr. Carpenter on the shore of Bugalla, Sesse Islands: the 32 imagines had been bred (June 1, 1911) from scattered larvae found on Damba Island. There was much variation in the development of the black bars crossing the fore wing, which, in the darkest specimen, were far more completely fused into a single band on the right side than the left. Dr. Carpenter wrote concerning the specimens, April 18, 1912:—

"I am sending you bottled specimens of the Hypsid moth 'pactolicus' larvae and pupae. They are common on the shore, where their yellow papilionaceous food-plant grows very plentifully. They are splendid examples of conspicuousness: the larvae are visible from far. The white is the purest Chinese white I have ever seen on a live creature! The pupae are freely exposed, hanging in a few threads just enough to support them. It is difficult to imagine an insect more conspicuous in all its stages. The moth has a very slow, heavy flight (like a "Cinnabar"), and if handled exudes a strong-smelling, rather bitter-tasting fluid from behind each side of 'the collar' of the thorax. I thought you might like to have these; they are in dilute alcohol with a little glycerine. I

will try and photograph some *au naturel* next time the larvae appear in numbers. The brood of moths is just over."

The species *pactolicus* sent by Dr. Carpenter was closely allied to *bellatrix*, Dalm., which Mr. G. A. K. Marshall had seen caught and rejected by a young drongo (Trans. Ent. Soc., 1902, pp. 358–9). The specimen, which had lost most of its head, was now in the Hope Department.

DIURNAL MOVEMENTS OF ACRAEINE PUPAE.—Prof. POULTON said that he had received from Dr. G. D. H. Carpenter an account of curious changes of attitude observed in Acraeine pupae. The following statement formed part of the letter of April 18, 1912, already referred to:—

"Acraeine pupae (at least all that I have had) have a curious habit which I do not remember to have seen mentioned anywhere. They bend their body from side to side at more or less regular intervals of a day. Thus one day you see a pupa bent towards one side, and next day it is bent towards the

other, remaining motionless in these positions. Perhaps, as some Acraeine pupae at any rate are of aposematic colours, it is an advantage to show by change of position that they are animate objects, and drive home the warning. I have never seen any other pupa that hangs by the tail adopt changes of attitude."

PSEUDACRAEAS OF THE HOBLEYI GROUP ON THE SESSE ISLANDS IN THE VICTORIA NYANZA.—Prof. POULTON said that Dr. G. D. H. Carpenter had left Damba in December 1911, and after spending Christmas at Entebbe had gone in January to Bugalla Island in the Sesse Archipelago. The following extracts were printed from a letter written in February:—

"I am now quite settled, and am going to remain on Sesse. The fly have become very much more numerous lately, and are quite as numerous as I want. The change from Damba is very welcome, the scenery here being quite different. The island is mostly open grass land, rising some 200–350 feet above the lake, with patches and belts of forest here and there, and a belt of forest all along the coast. I went into this last Sunday, January 28th, and to my great delight found there representatives of all the *Planema-Pseudacraea* associations!

So neither you nor I need regret that I have left Damba. *Ps. obscura* seemed almost more abundant than on Damba, and its model [*Pl. paragea*] too (by the way, this seems to have more yellow on it than the Damba specimens); and on the very first time I went there I caught the most *lovely* specimen of a *Pseudacraea* intermediate between *Ps. terra* and *Ps. obscura* —far better than anything I ever got on Damba. In what I now regard as my apprenticeship to the *Pseudacraeae* I certainly *was* misled, as you suggest, by the rudimentary vein closing the hind cell. But now I can, with a certain degree of confidence, distinguish them from their models on the wing and at rest. Pseudacraeas are *very* much more alert, and rarely rest with the complete 'abandon' of the Planemas. Moreover, *Ps. obscura* and *terra* have a curious shiny appearance about them, especially on the under surface, as if they had been varnished; and, in the 'cadaver,' I find very many points of difference. Pseudacraeas have much thicker bodies; the palpi are larger; the antennae have practically no club, only [lxxxv a gradual thickening; and the shape of the wings is slightly different."

The following notes were written February 25th :—

"I think you will be delighted that I have left Damba; for the disproportion between *Planema* and *Pseudacraea* is even greater here, so much so that I look on Pseudacraeas as nothing, but consider it an event to catch a *Planema!* Of Pseudacraeas; *terra* abounds, *obscura* is not quite so plentiful, but lovely intermediates between the two are nearly as common as the types. *Hobleyi* is, I think, the scarcest—at any rate the female. I have only seen three *Pl. paragea* (two of which I caught and send you), no *Pl. poggei* or *macarista*, and very few *tellus*. I have seen no *A. alciope* at all, but *Precis rauana* occurs though I have not succeeded in catching it. On February 25th I saw two male *hobleyi* pursuing a *terra* in a very suggestive manner, and a *terra* pursuing a female *hobleyi* which fluttered stationary in the air also very suggestively."

[The following sentence was extracted from a later letter written from Sesse on May 1st: "I have already told you

that I have seen male *Ps. hobleyi* flirting with female *Ps. terra*, and *vice versâ*—both hovering flutteringly in the air. Since then I have seen a male *Ps. obscura* paying court to a female *Ps. terra* in the same way. This makes the observations complete! They were some 10–15 feet above the ground, and out of reach in every case. I am quite convinced that copulation and oviposition take place quite high up among the tree tops."]

"So far I have not succeeded in getting eggs, though I have kept four females full of ova: three have died without result, the fourth I have had for a week, and it is still living though it has hardly any wings left!"

Dr. Carpenter had also written in confirmation on April 27th:—"You will have seen from the first few I sent—which I hope to hear about in a week or so—how splendidly Sesse confirms the Damba records, the results being still more striking. I am so proud that I can supply such grand proof of the reality of the power of Natural Selection."

Prof. POULTON said that the Bugalla specimens of *Pl.* lxxxvi]
paragea, Grose-Smith, a male and a female, were of great interest because of the extended pale markings, resembling those of the most extreme varieties obtained by Mr. Wiggins in the neighbourhood of Entebbe. The five specimens from Damba Island, mentioned in these Proceedings (1912, p. xxiii), were on the contrary very dark forms. Mr. Wiggins's darkest and lightest examples were exhibited December 6, 1911 (Proceedings, p. xci). An account of the Sesse Pseudacraeas would be given at a later meeting when more material had arrived, but in the meantime it might be stated that the intermediate varieties between *obscura* and *terra* were a large proportion of the whole, and that they formed the most complete transition from the one pattern to the other. Dr. Carpenter's observations on the courtship of the Pseudacraeas of the *hobleyi* group afforded interesting confirmation of Dr. Jordan's conclusions based on the structure of the male armature. *Pseudacraea kuenowi hypoxantha*, Jord., was present in Dr. Carpenter's captures on Bugalla, although absent from those on Damba. Prof. Poulton had now received the whole of the butterflies

collected on this latter island, and explained that a few additions would require to be made to the lists of Pseudacraeas and Planemas published in these Proceedings (1911, pp. xci–xcv; 1912, pp. xix–xxiii). He hoped to bring a complete statement before a later meeting.

Papers.

The following papers were read:—

"Studies in the *Blattidae*," by R. SHELFORD, M.A., F.E.S.

Wednesday, October 2nd, 1912. [lxxxvii

COLEOPTERA FROM OXFORD.—Commander J. J. WALKER exhibited series of the following rare species of British Coleoptera, recently taken in the Oxford district:—

Lathrobium pallidum, Nord., found in flood-refuse of the River Cherwell at Water Eaton, Oxon.

Apion annulipes, Wenck., ♂ and ♀ taken by sweeping roadside herbage (red clover, *Trifolium pratense*, predominating) near Enslow Bridge, Oxon.

Psylliodes luteola, Müll., by sweeping grass on the outskirts of Kirtlington Park, Oxon.

"INSECT-CATCHING GRASS."—Commander WALKER also exhibited on behalf of Mr. A. M. LEA, Govt. Entomologist at Adelaide, S. Australia, a specimen of the so-called Insect-catching grass (*Cenchrus australis*) from Cairns, N. Queensland, with several *Coleoptera*, belonging to various genera, adhering to the spinous awns.

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Mr. C. J. GAHAN exhibited a small series of *Phromnia superba*, Melich, a dimorphic species of Homoptera of the subfamily *Flatinae*, taken by Dr. A. C. Parsons in Northern Nigeria, and read the following letter received from Dr. Parsons to explain the great interest attaching to the specimens:—

"*Haldon Terrace, Dawlish, S. Devon,*
"*26th August*, 1912.

"DEAR SIR,—With reference to my interview with you last June and our conversation at the Museum concerning certain Homoptera that I brought from N. Nigeria.

'The following is an extract from a letter that I wrote to my wife on the subject.

"'. . . I sat down at once to describe to you an extraordinary instance of protective mimicry that came under my notice. You must know that this last trip I have been in the habit of collecting new flowers and then trying to paint them when I get into a camp. One afternoon I found that the particular flower which I wanted to paint was dead, so I went into the "jungle" to try and find another specimen. But my attention was soon arrested by a most beautiful dove-coloured pea flower of sorts. "I will not bother about that other flower" I said to myself "but pick this one instead." On suiting the action to the word all the blossoms of my "flower" flew up in a cloud of fluff about my head and then re-settled individually among the brushwood. To use one of your favourite expressions, my "flower" was composed of several very pretty moths "on tiptoe for a flight." I cannot call to mind another instance of insects combining in that sort of way for mutual protection. These moths, whose folded wings are the exact shape of the keel part of a pea flower, were all arranged on the bare stem of some darkish bush; their heads were all pointing in the same direction and the colour graduated from green at

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the top of the twig to a deep dove colour that would indicate the oldest blossoms below. I was never so completely and so wonderfully taken in during my life, I well believe. I was able to catch about fifteen of the insects which I am sending to the Nat. History Museum, and I hope they will be able to reproduce what I saw.'

"The insects were taken in a village called Panda, which lies about 40 miles north of Keffi in the Nassarawa province of Northern Nigeria. The place of capture was a patch of dense undergrowth at the edge of a jungle stream and close to the village ford. It was in the month of October that I saw the insects, and the time of day was about 5 p.m. The insects had selected a branch which was apparently leafless

except at its extremity, and on this branch they occupied a length of some 9 inches : all the heads were pointing in one direction and that an upward one. I suppose that there were between 30 and 40 insects settled on the branch when I first saw it. After they had been disturbed they admitted of easy capture with a cap and all showed a tendency to re-assemble in the place where I first saw them, while none ventured far into the open.

"I have no recollection of seeing any flowers resembling in colour this pattern of insects, but racemes of leguminous flowers are a common feature in N. Nigeria.

"I could get no information on the subject from the natives.

"Finally, I should say that the insects have faded since their capture.

"Believe me,

"Yours truly,

(Signed) "ALLAN C. PARSONS, W.A.M.S.,

"Med. Officer, N. Nigeria."

Mr. Gahan said that Dr. Parsons' observations on this species were a strong confirmation of the account given by Prof. J. W. Gregory of a nearly related East African species in his book "The Great Rift Valley." He passed round a copy of the plate on which that species had been represented, and remarked that though it was undoubtedly inaccurate in showing

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the green insects at the top of the stem as being much smaller than the pink ones below, we now had no reason to doubt that these insects are at times to be found arranged in the manner shown on the plate, notwithstanding that Mr. S. Hinde had never seen them so arranged during the time he had them under observation (see Trans. Ent. Soc., 1902, p. 695). Prof. Poulton's suggestion that the insects are only arranged in the definite way described by Dr. Gregory, just at the period when they have reached the final stage, was in all probability correct, but it had yet to be proved correct ; and in a matter so interesting it was greatly to be desired that someone on the spot would carry out further observations with a few to settling that point. Mr. Distant had described as a distinct species the pink form shown on Dr. Gregory's

plate ; but knowing what we did of the close association of the two forms, he thought it was quite evident the two were merely forms of a single species, especially as no difference in structure had been pointed out.

West African Homoptera.—Mr. W. A. Lamborn exhibited a series of twelve *Homoptera* of the genus *Flata*, all taken feeding on one plant, 70 miles E. of Lagos, on Dec. 1, 1912. The insects were dimorphic, and he stated that the pink and green forms were mixed as they rested on the plant. He had not observed in these the definite arrangement according to colour mentioned by Mr. Gahan, although he was acquainted with the same species.

Prof. Poulton observed that the insect probably had the instinct for congregating, though not of colour-arrangement, and that in the two known instances in which the green specimens were found above and the pink below they had probably come out in that order, and had not yet flown, and that when once disturbed they congregated again, but promiscuously.

Euchelia jacobaeae, L., captured and then abandoned by a Robin.—Prof. Poulton exhibited an apparently uninjured example of *E. jacobaeae* given him by Mr. Roland Trimen, F.R.S., who had made the following observation on June 20, 1912. The moth was flying slowly at midday in his garden at Fawley, Onslow Crescent, Woking, when a robin

captured it on the wing and flew with it behind a bush. After about three minutes the bird flew away, and Mr. Trimen found the moth lying upon the ground. Although there was no obvious injury, except that one fore-wing was bent over and slightly rubbed, the insect seemed paralysed or almost dead. *E. jacobaeae* being, however, one of those moths that readily "feign death," and Mr. Trimen being anxious to preserve the specimen just as it was left by the assailant, he placed it without delay in a killing-bottle.

Wednesday, October 16th, 1912. [xcvii

Occasional migration due to excessive drought as a cause xcviii] of the spread of Butterflies into new localities.—Professor Poulton brought forward the following note on behalf of the Rev. K. St. Aubyn Rogers, and exhibited the two *Libythea* and the five *Asterope* (*Crenis*) therein mentioned :—

"The migration of butterflies is a subject of perennial interest and one on which many more observations are needed. It may perhaps be worth while to record a migration which took place at Rabai during the early part of 1911.

"The first species to be observed was *Catopsilia florella*, a species which is one of the best known migrants. The date on which the migration was first observed was March 12th, and it continued for some three weeks. At no time during this period were the migrants conspicuous for their large numbers, but every specimen of *C. florella* seen, appeared to have important business to the north, which urged it to keep moving steadily in that direction.

"Towards the end of this period I noticed that there were other butterflies joining in the movement, and on March 31st, I spent an hour in my garden capturing these. I found that *Atella phalantha* and the skipper *Andronymus neander*, the latter also previously recorded as a migrant, were represented in some numbers. However, the most interesting butterflies seen, as far as I was concerned, were *Libythea laius*, Trim., and *Asterope* (*Crenis*) *natalensis*, Boisd. Of these I captured two of the former and five of the latter in about an hour, and, as they were flying fast and high, it is evident that they must have been present in considerable numbers. The two species resemble one another on the wing, and when travelling fast are not easy to discriminate, but I am under the impression that the *Asterope* was proportionately more numerous than these figures would indicate. Now it is worth observing that neither of these species is common in the coast district of British East Africa, and I had not seen the *Libythea* since 1899, after a period of very prolonged and severe drought—conditions which were present, although to a lesser degree, in

1911. The *Asterope* I had only once previously taken in the district, although I think I saw it on another occasion. I have twice taken the *Asterope* in 1911, since March 31st, and have seen others, and I have also seen what I took to be a

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specimen of the *Libythea.* It remains to be said that the migration throughout was from S.S.W. to N.N.E., the wind being light from the E.N.E. Five days after March 31st the wind went round to the S.S.W. and blew strongly, the first heavy rains falling two days afterwards. This observation seems to indicate that butterflies which are usually non-migrants may be stimulated by abnormal conditions to become migrants, and that these occasional movements may enable the species to occupy new ground."

THE SPECIAL DEVELOPMENT OF MIMICRY IN FOREST BUTTERFLIES.—Professor POULTON brought forward a suggestion received from Mr. C. F. M. SWYNNERTON as to one of the causes which may have operated in the special development of mimicry in forest areas. The suggestion, which may be considered as a supplement to Mr. SWYNNERTON's earlier statement published in the Proceedings, 1912, pp. li–liii, was made in a letter written by him on May 25th of the present year. Mr. G. A. K. Marshall, who was familiar with the locality (Chirinda, S.E. Rhodesia) from which Mr. SWYNNERTON wrote, and to whom the paragraph had been submitted, regarded it as quite plausible and also novel:—

"I believe you are right in your view that the forest struggle for life 'is of a different kind.' Thinking it over after sending you my suggestion as to the possible dependence of such phenomena on the habitat of the model's food-plant, it struck me that a very frequently repeated observation of mine had perhaps a direct bearing on the point. It is that flying insects are often exceedingly difficult to recognise in forest as against veld. It is by no means easy at once to decide on the coloration of an insect seen flying in a blaze of light against a deep shadow or *vice versâ:* also they so frequently disappear behind foliage after having been in view for a few seconds only. Under those circumstances a mere trick of flight, or the smallest splash of colour in common, have often caused me to

take the insect for something that is otherwise utterly unlike it, and such a hesitation would usually cost a bird the insect. In this way *incipient* mimics should stand a better chance in forest than in open country and be more likely to survive beyond the incipient stages. I had previously applied the
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observation in thinking out the value of merely incipient likenesses, but had not thought of its bearing on the 'forest *versus* veld' problem when I replied to your question."

EURYTELA HIARBAS, DRURY, AND E. DRYOPE, CRAMER.—Professor POULTON drew attention to a letter he had received nearly two years ago from Mr. G. F. Leigh, describing the breeding of *E. dryope* and drawing the inference that the species was distinct from *hiarbas*. Mr. Leigh had thus been led by his own observations to revise his earlier conclusions on the subject (Proc. Ent. Soc., 1909, p. xxxv). The letter, dated Nov. 26th, 1910, was written from Durban:—

"I have to report that, breeding *Eurytela dryope* from a wild female (I cannot give the form of the male), I reared 22 offspring, all of which were *dryope*. Apparently, therefore, the two species *E. hiarbas* and *E. dryope* are different. Mr. A. D. Millar has a captured specimen, intermediate between these two butterflies, and such a form may, I think, be the result of a pairing between *dryope* and *hiarbas*."

MÜLLERIAN MIMICRY BETWEEN AUSTRALIAN BEES.—Professor POULTON exhibited on behalf of Dr. R. C. L. PERKINS a male of *Prosopis nubilosa*, Ckll., (*Prosopidae*), and of a species of *Halictus* (*Andrenidae*), captured by him in the Cairns district of North Queensland (July 1904). Dr. Perkins had pointed out to the speaker the extremely interesting manner in which the resemblance had been brought about, the hard glistening yellow mark on the black scutellum and post-scutellum of the *Prosopis*, and that on its lateral prothoracic tubercles being mimicked by a yellow pubescence occupying the same positions in the *Halictus*. The latter, having departed from the general appearance of its group, was clearly a mimic of the *Prosopis*, which bore a pattern also found in many allied species. The males and females of both model and mimic were alike, so that the resemblance would be equally

striking between the females. Dr. Perkins had suggested that a resemblance brought about in this remarkable manner, by means entirely different from those employed in the model, was certainly inexplicable on the hypothesis of climatic influence.

This mimetic resemblance had been fully described by [ci Cockerell (Trans. Amer. Ent. Soc., xxxvi, p. 201, 1910) who stated that certain species of the Australian *Paracolletes* also resembled the same *Prosopis* models. "The yellow dorsal patch in the *Prosopis* is tegumentary, in the *Paracolletes* due to hair, but the superficial effect is the same. To my astonishment I find also an *Halictus* with the same coloration (the patch due to hair), so similar to *Paracolletes flavomaculatus* that I had no doubt of its being a close relative until I came to examine it in detail." This species was described (*l.c.*, pp. 201, 202) by Cockerell from three ♀ specimens, from Macleay, Queensland as *Halictus paracolletinus*, and it was probable that the specimen exhibited was the ♂ of the same species.

A short discussion on the mimetic signification of this exhibit took place, in which the PRESIDENT, Prof. POULTON, Messrs. C. O. WATERHOUSE and G. A. K. MARSHALL took part.

COCOONS OF NORASUMA KOLGA, H. DRUCE, SPUN UNDER NATURAL CONDITIONS.—Dr. W. A. LAMBORN observed that some cocoons formed by larvae of this species in captivity had been previously exhibited by Professor Poulton, which, however, did not present quite the same appearance as those formed under natural conditions. The specimens now exhibited were formed by wild larvae under leaves and were found in the clearing at Oni Camp. They gave a better idea as to the mimicry of Braconid cocoons by the formation of little bosses of yellow silk. He remarked that it is the rule to find several cocoons under one leaf—frequently as many as twelve.

Papers. [ciii

The following papers were read:—

"Notes sur quelques espèces des *Lucanides* dans les collections du British Museum et de l'Université de Oxford," par M. Henri Boileau, F.E.S.

"Synaposematic resemblance between Acraeine larvae," by G. D. H. Carpenter, B.A., M.B., F.E.S.

Prof. POULTON, in giving an account of Dr. Carpenter's paper, exhibited the specimens referred to by the author, and drew attention to the fact that there were considerable differences between the females in the different families of *Acraea alciope*, Hew., bred on Damba Island. A large proportion of the females in some of the families exhibited a strong development of fulvous pigment along the outer border of the white bar crossing the hindwing, rendering them conspicuously different from the females in which this feature was absent
civ]
or nearly absent. There could be no doubt that the development of this colour in the hindwing was due to the appearance, by persistence or reversion, of the more ancestral pattern preserved in the females of the West Coast.

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cvi] Wednesday, November 6th, 1912.

A MYRMECOPHILOUS AFRICAN LYCAENID.—Mr. W. A. LAMBORN exhibited two larvae and two bred imagines with corresponding pupa-cases of the Lycaenid butterfly *Euliphyra mirifica*, Holl. The larvae were found in a nest of the ant *Oecophylla smaragdina*, var. *longinoda*, no less than 19 being obtained from three nests close together. Numerous other nests were examined but no more larvae came to light. The pupae were similar to those exhibited by Professor Poulton at the meeting of the Society held on March 20th this year.

THE VALUE OF PHOTOGRAPHS, EVEN WHEN GREATLY REDUCED, AS A RECORD OF HABITS, ATTITUDES, ETC.—Prof. POULTON exhibited a photograph of *Vanessa kaschmirensis*, Koll., taken in 1911 by Dr. C. William Beebe of New York at 12,000 feet on the Nepal-Sikkim boundary line in the Eastern Himalayas. Although the butterfly was reduced to an expanse of wing measuring one-tenth of an inch, it was quite possible, with the aid of a lens, to make out the pattern and to determine the species. The result showed that useful work, especially for bionomic purposes, might be done with a good camera even when reduction was carried to an extreme degree.

THE PRODUCTION OF THE SPHERICAL STRUCTURES ON THE

Cocoons of the Tineid Moth Epicephala chalybacma, Meyr.—Prof. Poulton read the following letter, written May 27th, 1912, from Peradeniya, Ceylon, by Mr. E. E. Green, and exhibited the cocoons referred to therein :—

"Your note, on p. xcv of the Proc. Ent. Soc., 1911, has prompted me to send you the enclosed small cocoons of *Epicephala chalybacma*, Meyr. The curious little bubble-shaped structures along the dorsum of the cocoon may perhaps be produced in the same way as the bodies on the cocoons of *Deilemera antinorii*, viz. *ab ano*.

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"Though the cocoons are extremely abundant in my garden, being attached to leaves of many kinds, to dead twigs, and even to sawn posts, I have never seen the larva at work or identified it in any stage. It is presumably a leaf miner at some part of its existence. I can only suppose that it migrates at night. I must have a search with a lantern."

Prof. Poulton in replying had expressed the hope that Mr. Green would study the subject further and try to find out the method by which the bubbles were produced. The observation was of all the more importance and interest because this species of Tineid was closely allied to *Marmara*, which produces similar structures upon its cocoon, as described in the Proceedings, pp. xcviii, xcix, 1911. There could be no doubt that the solution of the problem in *Epicephala* would provide the solution in *Marmara* also. Within the last few days Prof. Poulton had received the following paper and accompanying illustrations, dated August 16th, 1912, from Mr. E. E. Green.

Note on the construction of the cocoon of the Tineid moth *Epicephala chalybacma*, Meyrick.

By E. Ernest Green, F.E.S.

The remarkable little cocoons of *Epicephala chalybacma* have been abundant in my compound at Peradeniya, Ceylon, for many years. They are attached to the leaves and stems of many different plants, to posts and railings, or to any material that may happen to be in the neighbourhood. These white cocoons are elongate, with a median ridge or crest composed

of minute glistening globules, the nature of which has hitherto puzzled me. I could never find the caterpillars that were responsible for the structures. One particular post, that was constantly ornamented with the cocoons, has been watched—day and night—for some time. I naturally expected to find the caterpillars making the ascent. The ground at the base of the post was scanned minutely, but no wandering caterpillars were to be found. It really seemed that, if they did not come up from below, they must come down from above. One morning, after concluding my search, I instinctively glanced upwards,
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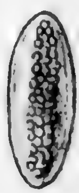
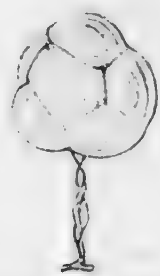
and there—sure enough—were several minute larvae, hanging by long silken threads from the overspreading branches of an "Inga-saman" tree (*Pithecolobium saman*). They had let themselves down from a height of 30 or 40 feet, and were



Cocoon of *Epicephala chalybacma*, dorsal view; × 3.



A single globule and silken cord; × 25.

swinging in the breeze. This part of the mystery was now solved. They hung suspended until the wind drove them against something solid, and there they immediately attached themselves and constructed their cocoons.

The caterpillar is small, but robust, measuring—when extended—about 6 mm. It is of a dull, pale, translucent green colour, with an irregular crimson band completely encircling each segment.

The construction of the cocoon is commenced immediately the caterpillar obtains a foothold. The position appears to be a matter of no consequence. The work is completed within two hours, which accounts for my failure to find uncovered larvae. After weaving a thin silken covering, the creature

rests for a few moments, and a convulsive movement of the posterior segments is noticeable. Very soon a globular pellet —apparently composed of dried bubbles—is voided whole. The caterpillar then turns round inside the cocoon, rapidly attaches the globule to the roof of the cocoon by a stout silken cord, bites a small hole close to the point of attachment, and pushes the globule and cord up through this aperture. The rent is then quickly repaired. This is followed by another short pause, the evacuation of a second pellet, and a repetition of the previous performance, the second pellet being placed at the opposite extremity of the cocoon, in consequence of the caterpillar having reversed its position in the cocoon. The
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same movements are continued, until the complete crest of globules is in position, when the labours of the little animal are over, and it composes itself for pupation. The number of pellets probably varies, but—in one cocoon—I have counted more than forty of these little objects.

Peradeniya, Aug. 16, 1912.

Prof. Poulton said that it was extremely interesting that Mr. Lamborn's original discovery of the structures in the cocoons of the Hypsid moth *Deilemera antinorii*, Oberth., had thus led to the further discovery of this still more elaborate method of producing similar results. He pointed out the curious optical effect whereby, when the cocoons were looked down upon from above, the bubbles appeared to be inside the silken wall although they were really resting on the outside of it.

Mr. Green's account differed in several important particulars from that given by Mr. T. Bainbrigge Fletcher and quoted by Mr. E. Meyrick, F.R.S., in his "Exotic Microlepidoptera," vol. i, pp. 21–22. Among other differences Fletcher described the spheres as "apparently . . . formed in the mouth" of the larva.

Mr. Durrant made a few observations with regard to the allied genera *Marmara* and *Epicephala* (*Gracilariadae*). The life-history of *Marmara salictella* was discovered by Dr. Brackenridge Clemens so long ago as 1859 or 1860, but the genus had not been recognised until a few years since, when

it was re-discovered by Mr. August Busck. Five species of *Marmara* are now known from the United States. It was interesting to find a similar habit in the same family in Ceylon.

The West African Agaristid moth Messaga monteironis, Butler, a mimic of the Hesperid Pyrrhochalcia iphis, Drury.—Mr. J. A. de Gaye, who was present as a visitor, showed examples of the above-named model and mimic captured by him under the following circumstances. One specimen of *Messaga monteironis*, Butl., from the Ikoyi Plain, Lagos, S. Nigeria, was caught at 6.20 p.m. on Jan. 30th, 1911, hovering over the flowers of *Anacardium occidentale*. On the same day and on the flowers of the same plant were caught two males of *Pyrrhochalcia iphis*, Drury, whose larvae feed

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on the leaves of *Anacardium occidentale*. The moth is a far better mimic of the female than the male Hesperid, the increased perfection of the likeness to the female being brought about by the white fringe at the apex of the forewing and the pale streaks which mark a sub-marginal section of all the nervures of both wings. The latter colouring probably produces on the wing a superficial likeness to the pale iridescent radiate streaks by which both wings of the female Hesperid are characterised. It is also noteworthy that the ends of the palpi of the *Messaga* stand out in front of the red head in a manner which strongly suggests the very characteristic appearance of the Hesperid. A similar difference in size between model and mimic is well known in many examples of mimicry.

The Pierine Genus Pinacopteryx.—Dr. F. A. Dixey

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made some remarks on the Pierine genus *Pinacopteryx*, illustrating them by exhibiting male and female specimens of most of the species, side by side with which were shown drawings made to scale of the plumules characteristic of each form.

He said: *Pinacopteryx* may be regarded either as a separate genus, or as a section of *Pieris*, the latter being the course adopted by Mr. Trimen in his work on South African Butterflies. It is a perfectly natural and circumscribed group, of which all the members are confined to the African

Continent, with a species or two in Madagascar. The plume-scales with which the males are provided show a general family resemblance, together with interesting specific differences. Their most characteristic feature is the expanded base, either rounded or angulated, of the lamina. In the distal portion of the lamina, the sides run nearly or quite parallel. Some of the species of *Pinacopteryx* are not easily distinguished, and in certain public collections there is a good deal of confusion between different forms. In cases of difficulty, much help is afforded by an examination of the plume-scales.

In West Africa we have the large pale-yellow form *P. cebron*, Ward, which inhabits the Gold Coast, S. Nigeria and the Camaroons. Its scent-scale is long and tapering, with an angulated base. Further south comes *P. falkensteini*, Dewitz (Angola; Congo), also large, but white instead of yellow. The plume-scale is much like that of *P. cebron*, but shorter. It has an unusually large accessory disc.

P. orbona, Hübn., also from the W. Coast, looks like a small specimen of the last, but has a quite distinctive scent-scale, in which the basal expansion is much diminished. *P. vidua*, Butl. (Upper Nile and Br. East Africa) is somewhat like the last species. Its scent-scale, however, is very short, broad in proportion, and with a widely-expanded angulated base.

P. pigea, Boisd. (Natal), of which *P. alba*, Wallgrn., is the dry-season phase, has a plume-scale with regularly rounded base and rather small accessory disc. In N.E. Rhodesia, Nyassaland and German E. Africa occurs a form closely allied to *pigea*, but generally larger, and frequently showing

in both sexes, but especially in the female, a considerable resemblance to *Mylothris agathina*; so much so that Mr. Neave says that he has often mistaken the females, when on the wing, for females of that species. This is the form referred to in Proc. Ent. Soc. Lond., 1907, p. lxv, though some of the statements there made require modification in the light of subsequent knowledge. A pair of this form from Fwambo are the types of Mr. Butler's *P. astarte*. The

scent-scales are of the general *pigea* character, but longer and narrower than in the Natal representative of that species. Forms of the *pigea* group from British E. Africa and Uganda depart from the Central African type and approach the Natal *pigea* in size, in general aspect, and in the character of their scent-scales, though the latter have usually a more marked basal expansion. The resemblance to *M. agathina* also tends to disappear in specimens from these more northern regions. But in a *pigea* form from Toro (Uganda), which is perhaps to be identified with *P. rubrobasalis*, Lanz, the resemblance to *M. agathina* is once more considerable. That this is distinct from the ordinary *pigea*-form (which also occurs in Toro) is made probable by the fact that its scent-scale is peculiar in the attenuation of its basal expansion, thus contrasting markedly with the scent-scale of the allied insect inhabiting the same district. The basal flush and black marginal spots, so characteristic of *Mylothris*, are in this Toro *rubrobasalis* especially well marked. In these particulars it corresponds with Butler's *P. astarte*, but is readily separable from that insect by its inferior size and distinctive scent-scale.

P. dixeyi, Neave, also from Toro, is in both sexes very like a *Phrissura*. It is, however, clearly shown to be a *Pinacopteryx* both by its neuration and also by its scent-scales. These have the usual *Pinacopteryx* character, but are larger and longer than any in the *pigea* group, having a widely-expanded and rounded base, much like that of *P. liliana* shortly to be noticed. The outline recalls that of a chemist's flask with a very long neck.

In the small yellow species, *P. spilleri*, Spill. (Natal and British E. Africa), the scent-scale is rather short, with a widely-expanded and angulated base.

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There remains the group of species headed by *P. charina*, Boisd. In all of these the accessory disc is large, the base is abruptly expanded, and the distal portion of the lamina has its sides parallel. The species of this group may be said to be geographical representatives. In *P. charina*, Boisd. (Cape Colony and Natal), the scent-scale is like a chemist's combustion-tube. In *P. simana*, Hopff. (N.E. Rhodesia; Portuguese,

German and British E. Africa, and Uganda), the scent-scale is of similar character, but larger and also broader in proportion. *P. venata*, Butl., from the White Nile, has a shorter and broader scent-scale of the like pattern. The scent-scale of *P. liliana* (coast region of Mombasa) is very peculiar. It resembles in outline the thin glass flasks used in chemical laboratories, but its neck (which is much shorter than in *P. dixeyi*) has a decided list. The accessory disc is figure-of-eight shaped and unusually large. Some specimens of *P. liliana* are not easily separable from *P. simana*, though the latter is usually a smaller insect. A glance, however, at the scent-scales is sufficient to distinguish them at once.

The ordinary scales in *Pinacopteryx* are very often spatulate.

A word may be said in conclusion about the interesting butterfly named by Godart *Pieris doxo*. Godart's actual specimen was included in the Dufresne Collection, and is now in the Edinburgh Museum of Science and Art. The locality from which it came is quite unknown. An examination of the specimen, which I have lately been enabled to make by the kindness of Mr. Eagle Clark and Mr. Percy Grimshaw, has convinced me that it is certainly a female *Pinacopteryx*, but not, as has been thought, *P. venata*. It appears to me to be most probably a somewhat pale specimen of *P. simana*. It is very like examples of the latter from Uganda.

I may here draw attention to Mr. Grimshaw's paper on Godart's Lepidopterous and Olivier's Coleopterous types in the Dufresne Collection at Edinburgh. The paper, which is to be found in the Transactions of the Royal Society of Edinburgh, vol. xxxix, Part I, 1897, is perhaps not so widely known as it might be. It is accompanied by a plate in which

are figured eight of Godart's and two of Olivier's types; the former including a representation of the type of *P. doxo*. A photograph of this specimen, now exhibited with specimens of *P. simana* ♀ for comparison, I owe to the kindness of Mr. Grimshaw.

Protective Resemblance.—Mr. A. Bacot exhibited an

Acridiine Orthopteron from the Benguella Plateau, taken by Dr. Chas. H. Martin, F.R.S., which bore a very perfect resemblance to the scorched grass stems, on one of which it was resting, the grass in this region being burnt off each season by the natives, leaving charred tufts and stubble. Mr. Bacot also exhibited specimens of the Dipteron *Glossina palpalis*, var. *wellmani*, Austen, from Catumbella River.

Gigantic Larvae.—Mr. Eltringham exhibited two specimens of an unusually large Lasiocampid larva which had been presented to the Hope Department by Mr. C. A. Foster, who took them in Sierra Leone. A similar larva had been illustrated in the "Entomologist" for May 1886, though this specimen was stated to have come from South Africa. It was unfortunate that Mr. Foster only obtained the larvae on the eve of his departure for England, so that he could not keep them alive. They were covered, in addition to the hairs, with long sharp spines, which made them very unpleasant to handle. The spines were quite smooth but very sharply pointed. Each larva was about seven inches in length. Prof. Poulton suggested that the larvae might perhaps be *Gonometa subfascia*, Walk., or *G. regia*, Auriv. The females of both these species had enormous bodies, and although the moths looked small beside the caterpillars, such apparent want of proportion was common among the *Lasiocampidae*.

Papers.

Prof. Poulton read a paper by G. H. D. Carpenter, B.A., B.M., B.Ch., F.E.S., on The Life-History of *Pseudacraea eurytus hobleyi*, Neave, and in giving an account of Dr.

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Carpenter's work read the following letter written by the author on June 16th, 1912, from Bugalla in the Sesse Islands.

"I feel I can almost say, as did Charles Kingsley, 'At Last!' To-day, being a sunny morning after many wet mornings (this month so far has been as wet as any of the three preceding, which is unusual) I went butterflying. I saw a few freshly emerged Pseudacraeas, and secured three *terra* which I send, hoping you will be able to set them in

time for the Congress. Just as I was coming away I saw a beautiful *obscura*, whose large very pale areas indicated more than a touch of the female *hobleyi*. It was fluttering about from bush to bush, and was too shy to let me get near to catch it. At last it settled and hung from the underside of a leaf, and I was able to see it had a fairly distinct basal triangle. It remained motionless a few seconds, and though this attitude is exceptional for a *Pseudacraea* (they always rest on the upper side of a leaf with wings usually expanded), it never struck me what was up! I tried to catch it, but it flew off before I got within striking distance. It then occurred to me to look at the leaf and, to my inexpressible joy and excitement, there was a freshly-laid egg on the middle of the under surface, still moist with the secretion which fastened it to the leaf. The tree was a very small young specimen, only about six feet high, but it was the *same species* as that on which *Ps. lucretia* fed on Damba; and there was a small colony of these trees at that spot, which had hitherto escaped my notice. So if this egg produces a *Ps. terra* (and the chances are in favour of this, as *terra* is *much* the commonest here), you will have the proof you so ardently desire, seeing that the parent was a mixture of *hobleyi* and *obscura*! Any how, now that I know and have found the food plant, I may have better luck in getting a captive *Pseudacraea* to lay. There is just time for the egg, larva and pupa to develop before the Congress at Oxford is over, so that should the offspring be *terra* or *hobleyi* I will let you know. As of course there will be no time to *write* I will cable, just the one word, either *hobleyi* or *terra*. If it is *obscura* I won't cable, but will, of course, write. I feel that it will be such a splendid opportunity for making this result known, when you will be showing
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the Pseudacraeas with especial intent to prove their conspecificity by the intermediate forms."

Prof. POULTON explained that the cable with the word "terra" reached him on Aug. 19, nine days after the Congress had come to an end, and that he had published the discovery in a letter to "Nature" (Sept. 12, 1912, p. 36). The specimen itself had since arrived and was exhibited to the meeting,

together with all the other bred specimens referred to in the paper, including the parents of families B, C and D. The pupal cases of the bred *Pseudacraeae* were also exhibited beside the butterflies which had emerged from them, and, for comparison, there was included a series of the pupal cases of *Pseudacraea imitator*, Trim., from Natal, presented to the Hope Collection by the late Mr. A. D. Millar, of Durban. It was seen that the two flat dorsal processes were rather less pronounced and the cephalic processes distinctly shorter in the pupae of the Natal form. Comparing Dr. Carpenter's pupae with the whole series of 31 Natal specimens, it was also seen that the apices of the two dorsal processes of the Uganda pupae tended to be directed backwards more strongly, and that the contour of the processes and of the segments between them formed a festooned outline instead of one that was nearly smooth. The cephalic processes of the Uganda pupae tended to turn upwards (viz. dorsally) at the tip, those of *imitator* downwards, while the two processes of the latter were more frequently separated. The Uganda pupae showed the darker pigmentation, but this effect was probably due to conditions. It was highly probable that this procryptic pupa is susceptible to the colours and degrees of illumination of its normal environment. The method of suspension from the edge, near the leaf-tip or near some angle of a partially eaten leaf, was similar in both forms.

It was not necessary to assume that differences of the kind described above imply specific distinction. Dr. Carpenter's description of the way in which the hollow cephalic and dorsal processes gained their shape in the fresh pupa was an indication that they were of no morphological significance but merely an adaptation which promoted the concealment of the pupa by making it more leaf-like.

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The synonymy of the *Pseudacraeae* required considerable modification if we might assume from Dr. Jordan's researches and Dr. Carpenter's breeding experiments that the close allies of *Ps. eurytus.*, L., were an interbreeding community. Prof. Poulton had consulted Dr. Jordan on the subject and he had agreed that it would be desirable to iutroduce the

term "f. mim." ("*forma mimetica*") for the diverse forms of such a species as *eurytus* or the females of *Papilio dardanus*. The following names would now express the relationship between the forms of *eurytus* in the Uganda district.

Pseudacraea eurytus hobleyi, Neave.	Chief Models.
♂ f. mim. *hobleyi*, Neave.	♂ *Planema macarista*, E. M. Sharpe.
♀ f. mim. *tirikensis*, Neave.	♀ *Planema macarista*, E. M. Sharpe.
♀ f. mim. *poggeoides*, f. nov.	♂ ♀ *Planema poggei nelsoni*, Grose-Smith.
♂ ♀ f. mim. *terra*, Neave.	♂ ♀ *Planema tellus platyxantha*, Jord.
♂ ♀ f. mim. *obscura*, Neave.	♂ ♀ *Planema epaea paragea*, Grose-Smith.

The name *poggeoides* was suggested for female forms with the pattern of *tirikensis*, but a forewing colouring approximating to that of *hobleyi*. It would probably be found, when a long series was examined, that the orange bar of *poggeoides* was paler than that of *hobleyi*, just as *poggei nelsoni* was, in this respect, paler than *macarista* ♂. In addition to the above mimetic forms there were many intermediates, but these were usually so transitional that it was undesirable to give them names. To one of them, with a rather more definite pattern than usual—connecting *terra* with *hobleyi* and *tirikensis*—the

name *impleta* had been given by Grünberg (see Proceedings 1912, p. xxii, n.).

Wednesday, November 20th, 1912. [cxix

Exhibitions.

West African Rhopalocera and Hymenoptera.—Mr. W. A. Lamborn exhibited (1) a small company of the Nymphaline butterfly *Euphaedra ravola*, Hew., which he had bred in August last from larvae found together under one leaf near Oni Camp, Lagos. He said that he had bred up altogether five other companies from larvae of this species, and all the imagines turned out to be precisely the same. The larvae were purple-coloured, with a broad horizontal fringe of hairy yellowish white bristles.

He showed also a single bred *Euphaedra themis*, Hübn., and stated though this butterfly looks almost exactly the same as *E. ravola* except for scarlet patches at the base of the wings, so that there has been some speculation as to whether the two might not be forms of the same species, yet the larva was quite different in colour from that of *E. ravola*, being pale green with the same fringe of horizontal bristles, and it fed on a different food-plant.

Other larvae which he had bred up presenting similar general characteristics were those of *Euphaedra ruspina*, Hew., *Euryphura plautilla*, Hew., *Catuna oberthüri*, Karsch, *C. angustata*, Feld., and *Diestogyna feronia*, Staud., all of which, except *E. ruspina*, with which he had not been successful, changed to a bright green colour about twenty-four hours before pupation.

In the case of the gregarious larvae, *E. ravola* and both species of *Catuna*, this colour change must have a procryptic effect. The bright purple larvae of *E. ravola*, the brown larvae of *Catuna angustata*, and the bluish white larvae of *Catuna oberthüri* were always found hidden to some extent under leaves, and the change in colour should be of great value as a means whereby they were rendered less conspicuous when it became necessary for them to wander in search of a spot suitable for pupation.

The pupae of all these butterflies were light green.

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These various facts, indicating a close relationship between these species, afforded interesting confirmation of the sound-

ness of their grouping by systematists, which was originally based on a study of the anatomical features of imagines.

(2) Two bred families of the Pierine butterfly, *Leuceronia argia*, Fabr., with the ♀ parent in each case. The ♀ parent of the first family was yellow without any orange flush at the base of the forewing. This family consisted of three males and nine females, five of which were yellow and four white, and all these females exhibited an orange flush at the base of the forewing on the upper and under sides. In the second family the female parent again was yellow without orange flush. There were only two female offspring, one of which resembled the parent exactly, whereas the other, a white variation, showed the orange flush.

The results in tabular form were as follows :—

Family I :—

Parent, captured May 26th, 1912, yellow without orange flush, laid ova May 26th, died May 27th.

Pupated.	Emerged.		
June 14	June 24	1 ♀	♀ white
,, 15	,, 25	2 ♂, 1 ♀	♀ yellow
,, 16	,, 26	3 ♀	2 ♀ yellow, 1 ♀ white
,, 17	,, 27	1 ♂, 4 ♀	2 ♀ yellow, 2 ♀ white

All the females, white and yellow alike, with orange flush.

Family II :—

Parent, captured April 16th, 1912, yellow without orange flush, laid ova April 17th to 19th, died April 20th.

Pupated.	Emerged.		
May 9	May 18	1 ♀	♀ white
,, 11	,, 19	1 ♂, 1 ♀	♀ yellow

One female white with orange flush, one female yellow without orange flush.

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(3) An instance of the relentless war of species against

species noticed so particularly in the Tropics. On February 2nd, 1912, he noticed a large Diplopteron hovering over a large ant, as if about to attack it, and the ant seemed prepared to give battle. The wasp discovered his presence and flew off before he could catch it, and thereupon the ant put its head inside the rolled-up leaf on which it had been crawling when threatened by the wasp and dragged out the pupa of a small moth. The ant was secured and the pupa was kept in the hope that the moth would appear, as only one wing-case had been punctured, but on February 7th a Tachinid fly emerged from the pupa. The pupa-case of the moth was so transparent that the puparium of the Tachinid could be seen within it. Another possible interpretation of the action of the wasp was that it had discovered the pupa at the same time with the ant. These predaceous wasps had a wonderful instinct for discovering the whereabouts of their prey. In the course of last year a wasp was seen to alight on a rolled-up leaf containing a larva of the Hesperid *Rhopalocampta forestan*, Cram. It bit into the leaf at once, without any preliminary investigation as far as could be seen, and proceeded to drag its victim out through the hole, shifting its grip from time to time so as to obtain a more convenient hold.

Papers. [cxxiii

"The Butterflies of the White Nile, a Study in Geographical Distribution," by G. B. Longstaff, M.A., M.D., F.E.S.

A considerable discussion took place on the subject of Dr. Longstaff's paper. Col. Yerbury observed that the Desert Region really extended from Cape Verd to Delhi, and that its insect fauna was much more closely connected with its flora than with its vertebrate fauna. Many of the Pierines, whose larvae fed on desert species of *Capparis*, were, as Dr. Longstaff had found on the White Nile, abundant where they occurred, but their distribution was patchy. He also observed that the desert fauna was not drawn from one region only, but from all those that surrounded it, and that all became modified on settling in the Desert Region.

The Hon. W. Rothschild said that he had lately been

working through a large collection of desert insects, and that he could thoroughly endorse Col. Yerbury's observation that
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the Desert Region extends from W. Africa to India. He also remarked that the Egyptian flora was dependent on the Nile, and had consequently wandered out of its proper region. This would partly account for the presence of a desert fauna so far up the Nile as Dr. Longstaff had found it.

Several other Fellows also gave instances of species which had been found at widely different points of this extensive desert range.

Dr. F. A. Dixey remarked that a second species of *Papilio* had been taken on the White Nile.

Mr. G. A. K. Marshall observed with regard to the great number of specimens of *Teracolus* in comparison with the scarcity of individuals of other groups, that wherever this genus was abundant, even in other than desert areas, he had always found that there was very little else in the way of Rhopalocera.

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cxxx] **Wednesday, December 4th, 1912.**

Metallic Colour in Chrysids.—Dr. G. B. Longstaff exhibited a small box of Chrysids, and started an interesting discussion on the means by which the metallic coloration was produced, observing that coloration of this kind was probably always due to structure and not to pigment.

Prof. Poulton remarked that this metallic coloration in the Chrysids was always situated in chitin, that it was more probable that it was produced by thin plates than by fine lines, but might possibly be due to interference of light by extremely minute particles.

The President said that there were many more Hymenoptera besides the Chrysids which displayed metallic colouring; he had made many experiments on the subject and found that by transmitted light the actual colouring was, in all cases that had come under his notice, of a testaceous red, without any metallic appearance.

Mr. C. J. Gahan, Mr. F. Merrifield and Dr. T. A. Chapman also joined in the discussion, the two latter referring to M. Pictet's experiments on the subject.

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The forms of Leuceronia argia, F., in the Lagos district of West Africa.—Mr. W. A. Lamborn supplemented his previous account of two families of bred *L. argia* by referring to a short series of females taken at Oni between April 1st, 1910, and January 25th, 1911, a period including a whole wet season and a part of two dry seasons.

Of the series, seven were captured in the wet season and three in the dry; but the orange flush, sometimes found at the base of the hindwing, was not due to climatic influence, as was demonstrated by the following table:—

April 1,	1910.	Dry season.	1 female, yellow, with orange flush.
May 31	,,	Wet season.	1 female, yellow, without orange flush.
June 5	,,	,,	2 females, both white, without orange flush.
,, 14	,,	,,	1 female, white, with orange flush.
,, 26	,,	,,	1 female, white, without orange flush.
July 6	,,	,,	1 female, white, with orange flush.
Oct. 2	,,	,,	1 female, yellow, without orange flush.
Dec. 28	,,	Dry season.	1 female, white, without orange flush.
Jan. 25,	1911	,,	1 female, yellow, without orange flush.

Three families of Papilio dardanus, Brown, bred from known female parents in the Lagos district of West Africa (1912).—Mr. Lamborn referred to an account recorded by Prof. Poulton, in Proc. Ent. Soc. 1912, pages xiv–xvii, of three families of *P. dardanus* bred at Oni, and stated that he had since bred three more such families at the same place, each from a *hippocoon* female parent.

The females in each family were again all *hippocoon*, and it could be said generally that family IV resembled family I in the characteristics described, while families V and VI resembled families II and III.

Parent IV had a much larger white patch on the hindwing than V or VI, and the female offspring of IV inherited this character, as in parent I and its family (see pp. xvi, xvii).

The white spot in the forewing cell of the female offspring was very uniform throughout the families IV, V and VI, although a minute apical spot was separated off from the tip or distal end of the marking in one female of family IV, and in one of VI, but in no others. In one female of IV an hourglass-like constriction nearly divided the marking. As regards the sub-marginal band of the hindwing of the males, the numbers were not sufficient to render a good comparison possible; but there was no doubt that the males were, as a whole, more heavily marked than those of family I (see p. xvi). The sub-marginal band was almost continuous in the two males of family V, those of IV and VI being less heavily marked, but presenting much variation in the degree of development of the two gaps in the band.

The constitution of the families was as follows:—

Female parent, *hippocoon*, captured May 1, 1912; oviposited May 1 and 2; died May 4.

	DATE OF PUPATION, 1912.	DATE OF EMERGENCE, 1912.	NO. OF ♂ OFFSPRING.	NO. OF ♀ OFFSPRING. ALL HIPPOCOON.
Family IV.	May 25.	June 5.		1
	,, 26.	,, 6.		4
	,, 25.	,, 7.	1	
	,, 26.	,, 7.	2	8
	,, 26 (about).	,, 8.	2	
	,, 26	,, 9.	1	
	,, 27	,, 9.	2	
	,, 27 (about).	,, 9.	2	1
		Totals ...	10	14

Female parent, *hippocoon*, captured June 18, 1912; oviposited June 18–19; killed by monkey June 21.

	DATE OF EMERGENCE, 1912.	NO. OF ♂ OFFSPRING.	NO. OF ♀ OFFSPRING. ALL HIPPOCOON.
Family V.	July 30.	1	1
	Aug. 1.	1	3
	,, 2.		3
		Totals .. 2	7

Female parent, *hippocoon*, captured June 26, 1912; oviposited June 27; died June 28.

	DATE OF EMERGENCE, 1912.	NO. OF ♂ OFFSPRING.	NO. OF ♀ OFFSPRING. ALL HIPPOCOON.
Family VI.	Aug. 10.		1
	,, 11.	1	1
	,, 12.	1	2
	,, 13.	2	1
	,, 14.		1
		Totals ... 4	6

Mr. Lamborn further stated that family IV had been the subject of a little experiment suggested by Prof. Poulton, who wrote out to him on March 12th, suggesting that shock of some kind—as for instance by the cooling down of the pupae by means of ice—might possibly result in the production of ancestral characteristics.

The larvae pupated as noted in the above table between the 25th and 27th of May, and at nine p.m. on May 30th the temperature of the box in which the pupae had been placed was reduced by ice to about 50° F., which temperature was maintained till the evening of June 2nd. The ice had given out on the morning of June 3rd, and the experiment was then brought to a finish owing to difficulty in obtaining a further supply. On examination of the female offspring in the Hope Depart-

ment at Oxford, it was found that the hindwings in four out of the fourteen showed a very definite tendency towards the production of " tails." Furthermore, the hind margin of these wings, instead of being evenly rounded, presented, in differing degrees in the four specimens, a squarish outline with the rudimentary "tail" at the angle. Some of the specimens closely resembled the *hippocoon* figured by Prof. Poulton in Trans. Ent. Soc. 1906, pl. XIX, fig. 3, but in one specimen at least the undulation of the margin was far more reduced except at the "tail," and the appearance was therefore more square-like. Two females only out of all those comprised in the five other families showed a similar condition. These appeared in family I. Mr. Lamborn hoped to repeat the experiment on a larger scale, and carry it out more fully, in order to obtain conclusive evidence as to the effects of a lowered temperature upon this species.

FAMILIES OF PAPILIO DARDANUS, BROWN, BRED IN NATAL FROM FEMALE PARENTS OF THE TROPHONIUS, WESTW., FORM, BY MISS M. E. FOUNTAINE AND MR. G. F. LEIGH.—Prof. POULTON said that, at his desire, Miss Fountaine had kindly prepared the following account of the extremely interesting family reared by her in 1909—the only Natal family at present known in which *cenea* is other than the most numerous of all the forms.

"On the 5th of January, 1909, in Stella Bush, near Durban, (Natal) I caught a very old ♀ specimen of *Papilio dardanus*, f. *trophonius*, which I kept, hoping to obtain ova. On January 7th, she laid 28 ova (one of which I am inclined to think must have escaped my notice the day before). And up to January 11th a few more were laid every day, till, the number having reached 45, I released the ♀, in the 'glades.' On January 10th, 1 larva hatched out, on January 11th, 27 larvae, each

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of the remaining 17 hatching on the 4th day after the egg was laid. When the caterpillars were still quite young I left Durban and went up country to a place called Dargle (4,400 feet) not without some anxiety for my little larvae, which had all made a good start and were doing remarkably well. It was much colder up at Dargle, and it rained almost every day,

but I was fortunate enough to find plenty of their wild food-plant—*Vepris lanceolata*—growing in Kimber's Bush, about two miles distant from the hotel (and to which, thanks to the kind permission of Mr. Kimber, I had free access), so that I had not to resort to pillaging orchards for the leaves of orange and lemon, which also grew in the neighbourhood. The larvae grew as quickly and seemed to get on quite as well up here as down on the coast. The butterfly occurred in Kimber's Bush but was rather scarce, and I only saw males. On February 2nd 4 of the larvae (I had still nearly 40 of them) pupated, and 3 others were hanging up with that end in view. After that they went on pupating every day, until at last I had 38 pupae. The first emergence (1 ♂) took place on Feb. 19th; the next day, Feb. 20th, (2 ♂♂ and 1 *trophonius* ♀); Feb. 21, at Maritzburg (3 ♂♂); Feb. 22, (1 ♂ and 2 ♀♀ *trophonius*, and 1 ♀ *cenea*); Feb. 23, (4 ♀♀ *trophonius*, 2 of which were spoilt by emerging on the journey from Maritzburg to Donnybrook); Feb. 24, (3 ♀♀ *trophonius*); Feb. 25, (1 ♂); Feb. 26, (2 ♀♀ *trophonius*); Feb. 27, (1 ♂ and 2 ♀♀ *trophonius*); Feb. 28, (1 ♂); March 1, (2 ♂♂); March 2, (1 ♀ *trophonius*); March 4, (2 ♂♂ and 1 ♀ *trophonius*); March 5, (1 ♂); March 6, (1 ♂ and 1 ♀ *cenea*); March 7, 1 ♀ *trophonius* (deformed). Two others died in the pupa from the cold, but both were going to be *trophonius*.

"This makes a total of 37 (1 pupa having met with an accident), out of which 16 were ♂♂ (mostly of the broad-bordered summer form, though some of those that emerged in the cold at Donnybrook showed a slight inclination to narrower, more broken borders); and of the 21 ♀♀, 2 were *cenea* and 19 were *trophonius*."

Prof. Poulton stated that Mr. G. F. Leigh of Durban had written Oct. 5th, 1912, giving an account of an interesting family he had just reared from a *trophonius* ♀ captured in the
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Durban district. The *trophonius* parent was exhibited to the meeting The family was of the following constitution :—

11 males, 6 being very dark on the under surface; 4 *trophonius* females; 2 *hippocoon* females; 1 *leighi* female, a very fine and splendid specimen; and 9 *cenea* females.

The family thus bore a considerable resemblance to the much larger one bred by Mr. Leigh in 1910 from a *trophonius* female captured at Pinetown, Natal (Proc. Ent. Soc. 1911, pp. xxxiii–xlii). The fact that the *leighi* form had now appeared in a second family with *trophonius* parentage was of much interest.

Mr. Leigh also wrote in the same letter:—

"I have quite recently seen a male *dardanus* courting a female *Danaida chrysippus* in error, and so persistently indeed that I captured the specimens thinking I must have made a mistake and that the female was really the *trophonius* form."

FURTHER FAMILIES OF PSEUDACRAEAS OF THE HOBLEYI GROUP BRED BY DR. G. D. H. CARPENTER ON BUGALLA IN THE SESSE ARCHIPELAGO.—Prof. POULTON exhibited the two families and the leaves of the food-plant referred to in the following extracts from letters received from Dr. Carpenter. The history of the families he hoped might appear as part of an Appendix to Dr. Carpenter's paper in the Transactions. The numbers and letters referred to the figures of Dr. Jordan's plates.

"*Oct.* 14, 1912.

"I received Dr. Jordan's paper by the same mail as your letter and was amazed to see how the Western *eurytus* forms varied. I had not the least idea of it. Some of the forms I have seen here, and sent you, viz. one like 21A (which I take to show how *rogersi* arose), and a form like 14A or 15A, which I mentioned in my last letter. I did not know, also, that the form like *hobleyi* (24A) occurred in West Africa. It seems a strange thing that *imitator* does not vary. I should expect, if it did, to see the following slight variations in a long series.

"I. A trace of yellow in the subapical white area, *which is that of terra*, as shown very well by my beautiful bred

specimen B_2, which, as I remarked before, showed very well how *imitator* could have arisen from a mixture of *terra*, *hobleyi*, and *obscura*.

"II. A trace of yellow suffusion on f.-w. inner margin (due to *terra*).

"III. A diffusing of the h.-w. pale area, instead of its being concentrated. I think B_2 shows that the pale h.-w. area of *imitator* was derived from *obscura*, tinted white by *hobleyi* influence.

"I much look forward to seeing the Natal and West African *eurytus* forms."

Prof. POULTON had examined the series of *Ps. imitator*, Trim., in the Hope Department, viz. 35 specimens bred in 1910 by the late Mr. A. D. Millar, and 3 females captured at Northdene, Natal, in 1896. He agreed with Dr. Carpenter that B_2 could be easily transformed into *imitator*. With regard to I, no trace of subapical yellow was seen in any of the white-marked females. All the markings of the males and of a small proportion of the females were pale yellowish white like the males of *Planema aganice*, Hew., while the majority of the females were white-marked like the female *aganice*. II. The inner marginal marking was always present, yellowish in the yellow-marked, grey in the white-marked specimens. III. The bar crossing the hindwing was always well defined like the model—sometimes, however, more band-like and straighter along its outer edge, often, on the contrary, following the contour of the hind margin of the wing and forming a quarter-circle concentric with it, as in *Planema aganice*.

"*Oct. 17th*.

"I am sending you two more series of synepigonic Pseudacraeas with full data, and pupal skins of each specimen, also a few leaves showing the curious way in which they are eaten by the young larvae."

Prof. POULTON said that he had submitted the leaves to Dr. O. Stapf, F.R.S., of Kew, who had replied that they agree very well with *Sideroxylon brevipes*, Baker, a Sapotaceous plant well known in Uganda and allied to *Chrysophyllum*, a food-plant of *Pseudacraea* in the Lagos district and Natal. A

perfectly certain determination required fuller material, which it was hoped would soon be received from Dr. Carpenter.

Prof. Poulton had also received the following interesting note in a letter written on September 21st. The observation,

as Dr. Carpenter said, threw light upon a difficulty which has often been stated.

"I caught a very nice *initial variety of Ps. terra* the other day. It had a very slight yellow suffusion of the black ground-colour along the costal margin of the forewing, and the black bar between the sub-apical and hind-marginal tawny areas was slightly thinned away. This specimen, however, *looked distinctly different*, both at rest and on the wing, which tends, I think, to show how the smallest variations may have selection value. This is always rather a stumbling block, so it was nice to see it actually exemplified."

THE COCOONS OF EPICEPHALA CHALYBACMA, MEYR.—Prof. POULTON showed an enlarged photograph of the cocoons of *E. chalybacma* upon the leaves of Tamarind, *Poinciana pulcherrima,* taken at Pusa on May 31st, 1911, by Mr. T. Bainbrigge Fletcher. The cocoons with their spheres were very beautifully and clearly reproduced. The photograph had been taken for Mr. E. Meyrick, F.R.S., who had sent it to Prof. Poulton for exhibition to the Society.

A RICHLY-COLOURED EXAMPLE OF PLANEMA ARENARIA, E. M. SHARPE, FROM THE SESSE ISLANDS IN THE VICTORIA NYANZA.—Prof. POULTON exhibited a male specimen of *Pl. arenaria,* taken July 15, 1912, by Dr. G. D. H. Carpenter on Bugalla, one of the Sesse Islands. *Pl. arenaria* had been shown by Dr. Karl Jordan to be a pale eastern geographical race of the fulvous *Pl. consanguinea,* Auriv., of the tropical west coast. It was therefore interesting to find such forms, tending towards an intermediate tint, in an island in the Victoria Nyanza. Dr. Carpenter had observed that they were not uncommon.

THE EFFECT OF HOT AND COLD CLIMATE UPON THE COLOURS OF CHRYSOPHANUS PHLAEAS, L.—Prof. POULTON exhibited thirty-seven examples of *C. phlaeas,* captured on the same bank at Cerne Abbas, Dorset, in the hot August of 1911 and in the cold August of 1912, by Dr. R. C. L. Perkins. Eight

out of the fourteen males captured in 1911 were much darker than any of the eight males captured in 1912. The copper tint of the eight 1912 females was more brilliantly lustrous

than in the seven 1911 females. It was interesting that the effects were similar in kind in the two sexes, although very different in degree, also that the females, in which the difference was but slight, were more uniformly affected than the males.

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SPECIES OF THE GENUS TERACOLUS.—Dr. F. A. DIXEY exhibited specimens of *Teracolus ephyia*, Klug, and some allied forms, together with drawings of their respective scent-scales. He remarked that *Teracolus ephyia* was originally described and figured by Klug from specimens captured at Ambukol in Nubia. The uppermost specimen in the exhibit was from Meroe on the Upper Nile, close to the place where Klug's specimens were taken. Next came a pair, ♂ and ♀, captured by Dr. Longstaff near Khartum. The exhibit included a specimen of *T. lais*, Butl., caught at Artesia in Bechuanaland by Prof. Poulton. This form might be regarded as the geographical representative of *T. ephyia* in South Africa. With regard to the scent-scales, it was interesting to observe that a fairly gradual transition in size took place from one extreme to the other of the geographical series. All these forms appeared to be somewhat rare. Prof. Poulton's specimen of *T. lais* was the only one in the Hope Collection
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with the exception of two caught by Burchell, probably in 1812. The British Museum contained only two, or at the most three, of *T. lais*, and only three specimens of *T. ephyia.*

Dr. G. B. LONGSTAFF observed that many species of the genus look much alike on the wing, and that possibly *T. ephyia* may have been passed over as being inconspicuous among larger species.

Report of the Hope Professor of Zoology, 1910.

The following pages will indicate that 1910 was exceptionally important in the growth of the collections and the accumulation of material bearing upon the problems which have, for many years, been especially studied in Oxford.

There has been unfortunate delay in preparing the southern end of the Old Radcliffe Library for the reception of a part of the collection, and the congestion and inconvenience have been very great. There can be no doubt, however, that the additional space will be occupied and the collections arranged in it before the end of the present year.

Mr. R. Shelford's long illness and absence from Oxford have brought the working out of the Orthoptera to a standstill, and in many other respects he has been greatly missed. Mr. Shelford has, however, undertaken other valuable work which could be sent to him from time to time. The library has also suffered much from Miss Shelford's inability to continue her work.

1. *The Rothney Collection and Library of Oriental and British Hymenoptera, &c.*

This splendid donation, one of the finest received since the Department came into existence, arrived in perfect condition, with no single insect displaced—a result due to the complete and careful arrangements made by the generous donor, Mr. G. A. James Rothney, F.E.S., who himself superintended the loading of the van and bore the whole of the cost.

The collection consists of the following:—

(1) A fine 40-drawer cabinet nearly full of Oriental Hymenoptera, and extremely rich in types. The specimens collected by the donor in Barrackpore Park, Calcutta, Mussoorie, Allahabad, N.W.P., &c., are in very fine condition, and there are also series collected by Col. C. T. Bingham, and specimens from the collections of Bates, Cameron, Forel, and F. Smith. A large collection made by natives in the Khasia Hills, Assam, is very rich in types of new species not only among

the Aculeate Hymenoptera but also in the Phytophaga and the Parasitica. Special parts of the collection illustrate the habits and life-history of ants, and the mimicry of ants and of other Aculeate Hymenoptera. In addition to the Oriental material, ants from many other parts of the world are included in the collection.

(2) A 12-drawer cabinet containing English Aculeate Hymenoptera all in very fine condition. The collection contains the first male and female specimens of *Formica exsecta* taken in Britain, the example, until recently unique, of *Odynerus herrichii* (=*basalis*), Dorset, 1868, and many rare species.

(3) A large number of boxes containing Oriental insects of various orders, and one box of South American Hymenoptera. The Lepidoptera and Odonata (Dragon-flies) captured by the donor in Barrackpore Park are in very fine condition. Many of the latter series of Lepidoptera were contained in the last drawers of cabinet (1), but they have now, with the consent of the donor, been removed in order to be fully labelled and incorporated in the general collection. Their place in the cabinet is in part taken by Hymenoptera previously stored in unsafe "cartons," the majority forming a Javan collection presented by Mr. Rothney in the present year.

(4) Ninety-two volumes and a large number of unbound papers, of which the great majority deal with the Hymenoptera, and many with the material of the Rothney collection. See pp. 30, 31 for a further account of the books, &c., added to the Hope Library.

2. *Work done by the Staff.*

Mr. W. Holland, in addition to the periodical incorporation of specimens in the collections of various groups of insects, undertook the following important pieces of work:—the arrangement, verification of names, and classification of data of the 6,000 butterflies—chiefly Malayan—from the Van der Poll collection; the preliminary arrangement of several of the earlier families of moths; the re-arrangement of the large

collection of butterflies of the Nymphaline genus *Charaxes*; the mending, cleaning, and arrangement in 38 drawers of the Chevrolat *Carabidae*, from the Van der Poll collection. This last piece of work was especially heavy and of the utmost necessity, for the beetles when purchased were still contained in the original "cartons," with loosely fitting covers. The collection had been exposed to damp, and large numbers of specimens were covered with mould.

Mr. A. H. Hamm has assisted in the incorporation of Hymenoptera and Diptera, and has printed many large batches of labels, those for the Neave collection being the most important. His chief work, however, has been concerned with the fresh accessions as they came in, and especially with the consignment of Mr. W. A. Lamborn from the Lagos district. All of these were at once dealt with, so that they could be studied and the generous donor informed of the results without delay. Other donations which have occupied a large part of Mr. Hamm's time were those presented by Dr. G. B. Longstaff, Mr. F. C. Woodforde, Mr. C. A. Wiggins, the Rev. K. St. Aubyn Rogers, and Dr. R. E. Kunzé. He has also continued the readjustment of the specimens in the general collection of butterflies. This great piece of work will be completed in the present year.

Mr. Joseph Collins has continued the staging of the most delicate insects in the Dale Collection, completing the Hymenoptera Aculeata, Phytophaga, and Parasitica (begun in 1909). His most considerable work was the remounting and arrangement in 30 drawers of the second half of the British *Carabidae*, including about 4,000 specimens presented by Mr. W. Holland. He has also, with other smaller pieces of work, staged the 5–6,000 specimens—the material of the great Mendelian experiment—presented in 1909 by Mr. L. B. Prout, F.E.S., and Mr. A. Bacot, F.E.S.; labelled the large Atkinson Collection (chiefly Rhynchota) purchased many years ago; printed specific determinations and type and co-type labels for large numbers of specimens; labelled, in large part printed for, and numbered the accessions recorded in the later pages of this Report.

3. *Work on the Collections of Orthoptera.*

The state of Mr. Shelford's health entirely prevented him from coming to the Department last year, and from March 15, 1910, to April 11, 1911, he was absent from Oxford. He was able to write and publish one paper on *Blattidae*, to help in cataloguing the library accessions, and in entering up the catalogue of insect accessions—a laborious piece of work which was greatly needed.

4. *Work on the Collection of Pierinae.*

Dr. F. A. Dixey has been engaged in incorporating *Pierinae* from the collections presented by Dr. G. B. Longstaff, Mr. Neave, and Mr. Herbert Druce. This has involved a good deal of rearrangement of the group, which now occupies 380 cabinet drawers. He has also, in continuation of his work on the scent-producing apparatus in butterflies, devoted special attention to those genera of *Pierinae* which are not furnished with plume-scales, particularly to the genus *Dismorphia,* in which the patches of specialized scales concerned in the function of scent-distribution are of a peculiarly interesting character. Many preparations of these have been made, and the results are being got ready for publication.

5. *Rearrangement of the British Beetles.*

The rearrangement of the British *Staphylinidae* has been most kindly continued by Commander J. J. Walker throughout the past year, and now approaches completion. The carded examples have almost without exception made excellent specimens when cleaned and freshly mounted; but a very large proportion of the *Staphylinidae* are, according to the practice of the early part of the last century, mounted on pins of a size and make quite unsuitable for these delicate and fragile beetles. The specimens bearing Haworth's labels, and the series in Prof. Westwood's Collection, named (*circa* 1845) by Mr. F. W. Holme, are of especial interest, for they record the names given by the older naturalists. These have been retained upon the original pins, but have been carefully

cleaned and mounted on card "stages." In their present state most of them make at least presentable specimens.

The whole of the British *Carabidae* have now been arranged in 60 drawers, the earlier half in 1907, the later in 1910.

The University is deeply indebted to Mr. Holland for the gift of his very fine collection—of especial interest as coming in chief part from the Oxford and the adjoining Reading district; to Mr. Donisthorpe for examples of a very large proportion of the known British *Carabidae*, the rarest and most local forms no less than the well known; to Commander Walker for superintending the re-arrangement and himself manipulating the most delicate of the old Hope-Westwood specimens; and to Mr. Collins for the care with which he has re-arranged the collection and borne so large a part in the manipulation.

6. *Work upon the Burchell Collections.*

The manuscript of Mr. E. G. Joseph's work upon the Heliconine butterflies collected by W. J. Burchell in Brazil (1825–30) was completed by the end of 1909, but the paper was not published until April 1910 in *Ann. Mag. Nat. Hist.* (p. 322). Mr. Joseph then worked upon the Brazilian *Acraeinae*, and later upon the *Erycinidae*. The paper on the former group was published in the same journal (p. 9) early in the present year.

The Professor took the opportunity afforded by the meeting of the Entomological Congress at Brussels to submit the whole of the Coprid beetles collected in South Africa (1810–15) to Professor J. J. E. Gillet of Nivelles. This eminent authority kindly completed his examination in time for the Professor to bring the collection back to England. Many important modifications in the previous determinations were made by Professor Gillet.

7. *Assistance in Working out the Material of the Department.*

The kind assistance received in 1910 is, in large part, acknowledged in other sections of this Report. I desire here to acknowledge the generous and efficient help of the

Members of the Staff in the Insect Department of the British Museum of Natural History, of Mr. Hamilton Druce, and Mr. G. T. Bethune-Baker. Dr. Karl Jordan kindly examined at Tring and determined the Papilios of two important African groups, that of *P. menestheus* and of *P. nireus*, the specific distinctions in the latter being peculiarly difficult.

8. *Visits of Naturalists.*

The annual gathering of entomologists took place July 2–4, when the following Officers and Members of the Council of the Entomological Society of London were present:—Dr. F. A. Dixey, President; Mr. G. T. Bethune-Baker, Vice-President; Commander J. J. Walker, Secretary; Dr. Malcolm Burr, Mr. H. St. J. Donisthorpe, Mr. A. Harrison, Professor Selwyn Image, Dr. Karl Jordan, Mr. Hugh Main, and Mr. J. W. Tutt. The party also included Mr. W. Borrer, a member of the Entomological Club, and the following Fellows of the Entomological Society:—Mr. J. E. Collin, Mr. H. Eltringham, Dr. G. B. Longstaff, Mr. Guy Marshall, Mr. G. H. Verrall, and Col. J. W. Yerbury. The presence of so many eminent authorities was, as in previous years, of great advantage to the collections. It was furthermore a great pleasure to have the presence of so many naturalists who have generously assisted the University Collections. On other occasions in the year the Department has been visited by the following kind friends:—Mr. G. C. Champion; Mr. J. A. Cremer, of Zomba; Mr. W. J. Lucas; Mr. Guy Marshall; Mr. H. C. Robinson, Curator of the Selangor State Museum, Kuala Lumpur Museum, Federated Malay States; Mr. J. R. le B. Tomlin; and Mr. O. F. Watkins, of the British East African Protectorate. Before his return to Southern Nigeria, Mr. W. A. Lamborn studied in the Department some of the most important problems concerning the butterflies of West Africa (see pp. 16, 18).

Dr. G. B. Longstaff visited the Department many times in order to work out his fine collection of New Zealand insects, and, towards the end of the year, to study the

material described and figured in a comprehensive account of his observations about to be published.

Mr. W. B. Alexander, King's College, Cambridge, visited the Department in order to study the material of the Prout-Bacot Mendelian experiment on *Acidalia virgularia*. Professor Joseph J. E. Gillet of Nivelles kindly undertook, Sept. 22–28, a preliminary revision of the group of beetles in which he is so distinguished an authority, the *Copridae*. An important section of the family has since been sent to him for detailed study. Dr. R. Hanitsch, of the Raffles Museum, Singapore, has studied the Orthoptera, Mr. L. B. Prout the Geometrid moths, and Mr. Roger Verity, of Florence, the butterflies of the genus *Parnassius*. Mr. F. C. Woodforde, B.A., paid many visits to the Department, studying the British Lepidoptera, and suggesting necessary modifications. He also kindly assisted the Professor in arranging and checking the lists of the books and papers presented by Mr. G. A. J. Rothney, as well as other accessions to the Hope Library.

The Department was also visited by Professor F. Jeffrey Bell, M.A., Magdalen; Dr. Henry Bolus, of Kenilworth, near Cape Town; Prof. W. Haswell, F.R.S., of Sydney; and Prof. Adam Sedgwick, F.R.S.

9. *Works published in* 1910.

Mr. H. Eltringham completed the preparation of his important monograph, *African Mimetic Butterflies*, which was published by the Clarendon Press in the summer in time for the meeting of the first International Entomological Congress at Brussels. He also investigated the geographical distribution and relationships of two African Acraeine butterflies, *A. lycoa* and *A. johnstoni*, and completed a paper with two plates thereon, to be issued almost immediately by the Entomological Society of London. Mr. Eltringham then began to prepare a monograph on the whole of the Ethiopian species of *Acraeinae*, a work which is still proceeding. In the course of last year about 250 preparations of genitalia have been made and studied. Mr. Eltringham has not only examined the material in the Department, but that in the

British Museum and the Tring Museum. In the latter collection he has made a preliminary arrangement of the whole of the African Acraeas.

The state of Mr. R. Shelford's health only permitted him to write a single paper published in the course of 1910:—"A new cavernicolous cockroach" (Ann. Mag. Nat. Hist.), but the following memoirs written by him in 1909 appeared in the year now under review:—

GENERA INSECTORUM. *Blattidae*, sub-fam. *Epilamprinae*.
ditto ditto sub-fam. *Blattinae*.

On a collection of *Blattidae* preserved in amber from East Prussia. J. Linn. Soc., Zool. xxx, 1910 (p. 336).

Blattidae collected by Prof. W. Kükenthal in West Indies. Zool. Jahrb., Suppl. 11, Heft 2, 1910 (p. 105).

The following memoir also deals with the collections of Orthoptera:—

Third paper on the *Tetriginae* (*Orthoptera*) in the Oxford University Museum, by J. L. Hancock, M.D., F.E.S. Trans. Ent. Soc. Lond. 1910 (p. 346).

The following short papers have appeared in the *Entomologist's Monthly Magazine* for 1910 (second series, vol. xxi):

A new aberration of *Ephyra pendularia*, L., by F. C. Woodforde, B.A., F.E.S. (p. 144).

Notes on *Cetonia aurata*, L., and *C. floricola*, Herbst., by A. H. Hamm (p. 137).

Some Notes on the Lepidoptera of the "Dale Collection," now in the Oxford University Museum. Concluded. PYRALIDINA (including DELTOIDES), by Commander J. J. Walker (p. 185).

The following short papers, or brief descriptions of the material of the Department exhibited at the meetings of the Entomological Society of London in 1910, have been published in the Proceedings:—

Jan. 19, 1910, p. lxxxvii of the Proceedings for 1909. The Plume Scales of the *Pierinae*. The Presidential Address

read before the Entomological Society of London at the Annual Meeting, by Dr. F. A. Dixey.

March 2, p. xiv, Proceedings, 1910. Preliminary note on Mr. A. D. Millar's experimental breeding of forms of the Nymphaline genus *Euralia* in Natal, by the Professor.

March 2, p. xvii. The female of *Apaturopsis cleocharis*, Hew., taken by C. F. M. Swynnerton in S.E. Rhodesia, by the Professor.

May 4, p. xxxi. The Edibility of Lepidopterous Larvae, by H. Eltringham.

June 1, p. xli. The correction of an error in the account of the breeding of *Charaxes zoolina neanthes*, by the Professor.

An account of other work carried on in 1910, but unpublished in that year, will appear in the Report of 1911. The work on the Burchell Collections appears on p. 5 under a separate heading.

10. *The First International Entomological Congress.*

The first meeting of the Congress, held at Brussels during the first week of August, was very largely attended by British entomologists, including several naturalists who have associated themselves with the Hope Department. The Professor, with the kind help of Mr. H. Eltringham, conveyed the examples of three series of mimetic butterflies, collected near Entebbe from May 23 to September 30, 1909, by Mr. C. A. Wiggins. The combinations, ranged round three types of *Planema* (*Acraeinae*) pattern, occupied, together with the models, 11 large store-boxes. The whole had been provided by Mr. A. H. Hamm with printed labels, giving the names of the species and the dates on which they were captured. The *Planema* models were rendered conspicuous by red labels as well as by their position. The whole collection was carried to Brussels and back without injury. A memoir on the exhibited specimens will appear in the Report of the Congress.

The large attendance of British naturalists was recognized in the unanimous choice of Oxford as the home of the second Congress, to be held in 1912.

11. *Seventh Volume of Hope Reports.*

The seventh volume, issued at midsummer, contains reprints of 37 octavo memoirs which have appeared in the two years between June 1908 and June 1910. But for the pressure of work it would have been issued at an earlier date and in a less inconveniently bulky form. Many papers are already in hand for the eighth volume.

ADDITIONS TO THE COLLECTIONS IN 1906.

Nine butterflies from the Rio Huancamayo, Carabaya, East Peru (2,000 ft.), collected by G. R. Ockenden (1904), were presented by Herbert Druce, Esq., F.L.S., &c.

Five hundred and fifty-four Northern Rhodesian moths from the fine series collected in 1904–5, and presented by S. A. Neave, Esq., M.A., B.Sc., Magdalen College, have been catalogued and, with many hundreds of additional specimens, incorporated in the collection. Mr. Neave's moths have now been worked out by Sir George Hampson (Proc. Zool. Soc. 1910, pp. 388–510), and it was thought desirable not to incorporate the specimens until the specific determinations and reference to the memoir could be placed upon them. This has now been done, and the series is a most valuable addition to the University Collection. Many of the specimens are co-types of new species described by Sir George Hampson in the above-mentioned work. A full account of the localities was published in the Report of 1908.

ADDITIONS TO THE COLLECTIONS IN 1908.

A valuable series of *Asilidae* (Diptera) from the Bigot Collection (c. 1845–93), presented by G. H. Verrall, Esq., in 1908, has now been added to the general collection kindly arranged by Colonel J. W. Yerbury. This generous gift also included many *Asilidae* from other parts of the donor's collection. All the specimens have been supplied with printed labels clearly indicating their source.

Six hundred and eighty-eight moths—Geometers, Noctuas, Pyrales, and Micro-Lepidoptera—and one Phryganid, from the

Khasia Hills, Assam (*c.* 1904), presented by Herbert Druce, Esq., F.L.S., &c., have been catalogued and, with many others, incorporated. This is a further instalment of the splendid series from this interesting locality presented by the generous donor. Several instalments of equal or larger extent have been acknowledged in earlier Reports.

Sixty-eight insects of various groups and one Acarid, from Durban and Camperdown, Natal (1908), were presented by the captor, G. F. Leigh, Esq., F.E.S. Three sets of parasitic Hymenoptera, bred by the donor from the pupae of moths, 2 Hemiptera from ants' nests, and a Neuropterous insect allied to *Bittacus* with its Dipterous prey, are included.

ADDITIONS TO THE COLLECTIONS IN 1909.

Two hundred and seven insects of various groups from Durban and Pinetown (*c.* 1,000 ft.), Natal, were presented by the captor, G. F. Leigh, Esq., F.E.S. Included in the series are a *Salius* with its victim, a Lycosid spider, and two Asilid flies with their prey—a Pentatomid bug and a bee respectively. These will form an interesting addition to the bionomic collection.

The localities of the great collection made, Jan.–Sept., 1908, in N. Rhodesia, by S. A. Neave, Esq., M.A., B.Sc., Magdalen College, were fully described in the Report of the year 1909. The moths have now been worked out, together with those of Mr. Neave's earlier collections, by Sir George Hampson (see p. 10), and 380 have been catalogued and, with many hundred additional uncatalogued specimens, incorporated in the collection. With the exception of a few specimens which are still without their printed labels, the whole of the moths presented by the generous donor in 1906 and 1909 have now been incorporated, forming a splendid addition to the Ethiopian material which is so marked a feature of the Hope Department.

Sixteen males and two females of the little fritillary *Argynnis cytheris*, from the McClelland R., Tierra del Fuego (1904), were presented by the captor, Captain R. Crawshay. Three males and one female were added to a special faunistic

collection illustrating the northern affinities of the butterflies in the south temperate sub-region of South America.

The following valuable donation was presented by P. de la Garde, Esq. One hundred and sixty-one Rhynchota Hemiptera and Homoptera, captured in the following localities: S. Africa (1892–4) chiefly Simonstown, Zanzibar (1893), Rarotonga (1896), Fiji (1896), Sydney (1898), Hobart (1897), Queensland, Brazil (1900), Monte Video (1900). Two hundred Lepidoptera, chiefly butterflies, from a great variety of European localities (1890–1904), and 15 Lepidoptera from Asia Minor, &c. An example of *G. rapae*, the "Small Garden White," bred at Teignmouth (April 2, 1905) from a pupa imported with bananas from the Canary Islands. An ant from Monte Video.

In addition to the above, 6,000 butterflies, almost exclusively Malayan, and the Chevrolat Collection of *Carabidae*, both forming part of the Van der Poll Collection, were presented by the Professor in 1909.

Additions to the Collections in 1910.

Very fine accessions to the collection of Lepidoptera are due, as in previous years, to the generosity of Herbert Druce, Esq., F.L.S., F.E.S., &c. Specimens from the following localities have been incorporated:—

Khasia Hills, Assam, 543 moths—chiefly Geometers and Pyrales—and 3 Neuroptera. This series, of which 283 have been catalogued, completes the fine collection from the Khasia Hills, referred to above and in many earlier Reports.

Chanchamayo, Peru, 4 fine examples of the Syntomid moth *Isanthrene joda*, H. Druce.

Carabaya, Peru (G. R. Ockenden; various localities and dates), 531 moths (chiefly *Geometridae*) and 17 butterflies.

Upper Kassai River District, Congo State (Paul Landbeck), 287 butterflies and 40 insects of various groups. The butterflies include many *Lycaenidae* and *Hesperidae* especially wanted by the Department.

Bitje, Ja River, Cameroons (G. L. Bates, 1909), 321 moths,

25 butterflies, and 1 Homopteron. Also 9 butterflies from the Cameroons without further locality.

Accessions from these South American and West African localities are especially welcome to the Department.

A fine series of moths from the following American localities was presented by the captor, Commander J. J. Walker, Hon. M.A., F.L.S., F.E.S.:—

Callao, Peru (Mar. 31—July 17, 1881, and Dec. 13, 1882—Jan. 8, 1883), 117 specimens.

Callao, Peru, S. Lorenzo Island (Sept. 1–10, 1881), 5 specimens.

Valparaiso, Chile (1882–4), 45 specimens.

Coquimbo, „ („), 55 „

Talcahuano, „ (1884) 16 „

Arica, „ („) 10 „

Panama and Taboga Island (1882), 4 specimens.

Esquimalt, Vancouver Island (1882), 62 specimens.

Various localities and dates, 14 specimens.

The data are detailed and precise, and the whole a valuable addition to the general collection of moths.

Commander Walker also presented 33 Australian butterflies (*Hesperidae*), collected in various years in the Sydney district and named by G. A. Waterhouse, Esq. The specimens are a welcome addition to the rather poor collection of Australian "skippers" in the Department.

Six European beetles determined by Herr Formanek, 3 (from Sweden) by Dr. L. B. Ericson, and 4 (Loire-Inf.) by Monsieur H. St. Cl. Deville were presented by H. Donisthorpe, Esq., F.E.S.

A valuable series of 41 cocoons of Saturnian moths, partly bred in captivity and partly found wild in various localities, was presented by J. H. Watson, Esq.

Fifty-five butterflies and 209 moths from Cornwall and Staffordshire (1910), with 7 from other British localities, were presented by the captor, F. C. Woodforde, Esq., B.A., Exeter. This accession is in addition to the fine series presented by the same donor to the British Collections (see p. 22).

An interesting series of about 100 European Micro-

Lepidoptera, at one time part of the collection of the late Henry Doubleday, was presented by Mr. Joseph Collins. A list of names in Doubleday's handwriting gives an added interest to the donation.

Five moths and a Hesperid butterfly from localities of great interest in N. Kashmir (1909) were presented by the captor, Lieut. T. G. Longstaff. The Hesperid was from Chulung (14,800 ft.), Baltistan, Karakoram Mts. (July 11); 3 Geometrids from Upper Saltoro Valley (12,000 ft.: June 27); 2 Noctuids from Ladak (16,000 ft.: Aug. 16).

A series of 61 butterflies from British New Guinea was presented by S. A. Neave, Esq., M.A., B.Sc., Magdalen College. The specimens were given to him by G. T. Bethune-Baker, Esq., F.L.S., F.E.S., in exchange for N. Rhodesian butterflies. Nearly all the specimens were taken by the experienced collector A. E. Pratt, and the localities and dates are precise. The Department is very poor in material from this most interesting island, and the donation is correspondingly valuable.

Twenty Lepidoptera from Cooktown, N. Queensland (1897), 9 of uncertain locality, and 4 butterflies from Thursday Island (1897), were presented by P. de la Garde, Esq.

A fine set of 12 *Vanessa gonerilla*, "The New Zealand Admiral," from Christchurch (bred probably in 1909), was presented by F. S. Oliver, Esq.

Four examples of *D. strigosa*, the Arizona form of *Danaida berenice*, and three of its mimic *Limenitis* (*Basilarchia*) *hulsti*, from Tucson (2,400 ft.), S. Arizona (1896), together with another example of *hulsti* from Phoenix (1,100 ft.), S. Arizona (1897), were presented by the Brooklyn Museum, N. Y. The specimens were captured by Dr. R. E. Kunzé, who has himself presented the very fine collection of insects mentioned on p. 20. All the mimetic N. American forms of *Limenitis* except *hulsti* have been studied in the Department (Trans. Ent. Soc., Lond., 1908, pp. 447–88), and it will be especially interesting to make a detailed examination of this remaining example. Such work can now be undertaken under very favourable circumstances, thanks to the kindness of Dr. Lucas, Curator of the Brooklyn Museum, and Dr. R. E. Kunzé, who

has since presented many further specimens of both model and mimic.

Forty-two Heliconine butterflies, including an example of the rare *H. nanna*, 7 *Papilioninae* and 3 *Nymphalinae* (*Kallima*), from various localities, were presented by the Hon. Walter Rothschild.

The accessions from the Ethiopian region form, as they have done for many years past, the most important additions to the University Collections.

A very fine series of 420 Lepidoptera, of which 182 have been catalogued and nearly the whole incorporated in the collection, was presented by the captor, W. A. Lamborn, Esq., M.R.C.S. The specimens were taken about 70 miles east of Lagos, at Oni, on the east shore of the Lekki Lagoon, about 10 miles from the sea. The elevation is low (0–100 ft.), and the country around covered with primitive forest with paths and native clearings. In Oni clearing and in the forest for 5 miles to the east of it the collection was made between Dec. 1, 1908, and Dec. 3, 1909. The most interesting specimen was a remarkable Lycaenid of a new genus and species since described as *Neaveia lamborni* of H. H. Druce. Many other *Lipteninae* (*Lycaenidae*) were greatly wanted by the Department. Among the *Nymphalinae* the fine *Neptis nebrodes* was new to the University Collection. The *Danainae* included a male example of *Amauris niavius* in which the scent-patch of the right hind-wing had been eaten by ants. Specimens from the West Coast of Africa with full and precise data have long been one of the chief needs of the Hope Department; so that this gift is of unusual value and importance. Since the donor's return to Oni early in the year he has continuously collected, observed, and recorded for the Department, and by the date of his return to this country at the end of April, 1911, had sent specimens occupying 100 cabinet drawers. A large part of the labelling has been done, but the cataloguing and incorporation cannot be finished in time for this Report. The observations will be published as an important memoir on the habits, &c. of West African Lepidoptera. A specially valuable part of the work results from the large amount of

breeding which the author has undertaken, and the volume of observations on the early stages of Lepidoptera which he has made.

Two of Mr. Lamborn's observations are so important and interesting that it is necessary to record them briefly without further delay. The first is one of the most striking examples of Protective Resemblance that has ever been discovered—the caterpillar of a Hypsid moth, *Deilemera antinorii*, which heaps upon its cocoon a mass of frothy spheres, possessing when dry an extraordinary likeness to the minute cocoons of parasitic Hymenoptera clustered around the dried body of their victim. The defence is doubtless against the Vertebrate enemies of the pupa. The second observation throws remarkable light on certain secondary sexual characters of male *Danainae*. These butterflies commonly possess a double tuft of hairs which can be protruded from the posterior extremity of the body, as well as "brands" or patches of peculiar scales on the wings. Both characters have been interpreted as scent-producing organs employed in courtship. The relationship between them, although suggested by Fritz Müller, has never until now been observed. In January of the present year Mr. Lamborn saw a male of *Amauris niavius* brushing the brands on its hind wings with the protruded tufts, as though some secretion was being conveyed from the one to the other. The greasy appearance of the brands may be probably interpreted on the hypothesis that they serve to retain and distribute the scent brought to them by the tufts.

In addition to the splendid donation from the Lagos district, 5 butterflies from Ladysmith, Natal (June, 1908), were presented by the captor, W. A. Lamborn, Esq.

A fine series of 196 Coleoptera and 6 Rhynchota from Brazzaville, French Congo (Aug.–Dec., 1909), together with 35 Coleoptera and 1 Hemipteron (Dec. 1909—Mar. 1910), were presented by H. Eltringham, Esq., M.A., New College. The series, of which nearly the whole is catalogued, includes a set of Lycid models and their Longicorn mimics, for the bionomic series.

Three examples of a beautiful Geometrid moth, *Zamarada*

rufilinearia, collected in Nyassaland by S. A. Neave, Esq., M.A., B.Sc., Magdalen College, were presented by the Entomological Research Committee of the Colonial Office.

Forty-three butterflies from the Wassaw District of the Gold Coast were presented by the Hon. Walter Rothschild.

Of great interest is an example of the female form *inaria* of *Hypolimnas misippus*, captured at sea (Jan. 19, 1910) 30 miles from land and 50 north of Mombasa, and presented by S. A. Neave, Esq. Thus further evidence of the wandering habits of this butterfly is added to that already in the Department.

A deeply interesting family of 11 butterflies bred from a female *Hypolimnas* (*Euralia*) *mima* was presented, together with 11 pupa-cases, by A. D. Millar, Esq., of Durban. The female parent, captured at Mount Edgcumbe, near Durban, laid eggs Nov. 21, 1909: the offspring completed their life-history in a month or under, all emerging from the pupa Dec. 19–22. Eight of them, 5 male and 3 female, are *mima* like the parent, mimicking *Amauris echeria* and *albimaculata*. The remaining 3 are male examples of the butterfly previously known as *Euralia wahlbergi*, a mimic of *Amauris niavius dominicanus*. Indirect evidence that *mima* and *wahlbergi* may be the dimorphic forms of a single species was brought forward by Mr. Guy A. K. Marshall in 1902 (Trans. Ent. Soc., Lond., pp. 491–2). The paper is reprinted in Vol. III of Hope Reports, and it is of great interest that a part of the conclusive direct evidence obtained 7 years later should have found a place in the Department. Mr. Millar is to be warmly congratulated on his success in solving a most interesting problem. A full account of this and his other successful results with Euralias has been published in Trans. Ent. Soc., Lond., 1910, p. 500, by Roland Trimen, Esq., Hon. M.A., F.R.S.

In the 1902 memoir referred to above the Professor wrote on p. 492: "If Mr. Marshall's conclusion be established, it follows that the corresponding and closely-allied mimetic West African forms *Euralia anthedon* and *E. dubia*, connected like *wahlbergi* and *mima* by intermediate varieties, are similarly

the dimorphic forms of a single species." In a few weeks this question will also be settled by the arrival in Oxford of families bred from these two forms in the Lagos district by that most generous helper of the Department, Mr. W. A. Lamborn.

[Since the above paragraph was written, the question has been settled; for two families of known (female) parentage have been received from West Africa. The female parents were both forms of *E. dubia*, and yet *anthedon* is abundantly represented in both sets of offspring, each containing over 100 individuals. E. B. P., May 22, 1911.]

The great interest of Mr. Millar's discovery is that the dimorphism is unconnected with sex, males and females being equally present in both forms. Dimorphism or polymorphism in one sex, as in the females of *P. dardanus*, mentioned below, is well known. Dimorphism like that of the Euralias has hitherto been looked upon as exceedingly rare.

A beautiful pair of *Hypolimnas* (*Euralia*) *deceptor*, bred May 7–8, 1909, from eggs laid Mar. 24–5, was also presented by A. D. Millar, Esq. The female parent was captured at Mount Edgcumbe. The same generous donor has presented a fine series of bred Pseudacraeas and other Natal butterflies. These have received their printed labels, but have not yet been catalogued. They will be acknowledged in detail in next year's Report.

An extremely interesting family of *Papilio dardanus cenae* was purchased from Mr. G. F. Leigh, F.E.S. The female parent, of the relatively rare *trophonius* form, was captured June 26, 1910, at Pinetown, Natal (about 1,000 ft.), and laid 62 eggs on June 27 and 28. Mr. Leigh succeeded in breeding no less than 55 butterflies, all of which emerged from the pupa between Aug. 26 and Sept. 8, 1910. Of these 25 are males (non-mimetic) and 30 females, a result which supports the conclusion that the rarity of the females is only apparent and due to their retiring habits. Of the 30 females 22 are the *cenea* form, mimicking the commonest Danaine butterflies in Natal, *Amauris echeria* and *A. albimaculata*; 4 are *trophonius* like the female parent, mimicking the abundant Danaine

Danaida chrysippus; 2 are *hippocoon*, mimicking the conspicuous black and white Danaine *Amauris niavius dominicanus*; 2 are a remarkable unnamed form known to occur occasionally in Natal and evidently representing the *planemoides* form which, much further to the north, mimics the Acraeine butterflies *Planema poggei* and the male of *Pl. macarista*. But in the absence of the models, which do not come within many hundreds of miles of Pinetown, the pattern of the female form differs in many respects from that of true *planemoides*. Another very interesting feature in the family is the evident effect produced by the *trophonius* parent upon offspring belonging to a different form. Thus the pale hind-wing patch in several of the *cenea* females is of an unusual fulvous tint—a clear effect of the dominant colour of *trophonius*. This result compares in a most interesting manner with another family bred in 1906 by the same keen naturalist and also in the Hope Department. In this latter some of the *cenea* offspring similarly show the effect of the white in the hind wing of the *hippocoon* parent (Trans. Ent. Soc., Lond., 1908, p. 436). This recent accession is the most remarkable of the 7 families of *P. dardanus* in the Department.

In addition to the above accessions, a few others of great importance must be mentioned although not yet incorporated.

The Royal Museum of Natural History of Brussels presented a fine representative series of butterflies from the Congo State. The collection had been selected to exhibit to the King of the Belgians, and the specimens are beautiful examples of their species. They are a welcome addition to the African collection from a part of the continent that is but poorly represented here.

A great deal of time has been devoted to the wonderful mimetic series collected in 1909 and 1910 in the neighbourhood of Entebbe by C. A. Wiggins, Esq. (see p. 9). A great part of the setting and labelling has been done and it is hoped that, in collaboration with Mr. Wiggins, who is now in this country, the whole of the material may be studied and arranged in the course of the present year.

The generous help to the University Collections which has

been rendered for so many years by the Rev. K. St. Aubyn Rogers, M.A., Wadham, F.E.S., has been continued in 1910. The very interesting British East African butterflies, chiefly from the neighbourhood of Rabai, near Mombasa, sent by him in 1910 have, with few exceptions, received their printed labels. The amount of work that was necessary in preparation for the return of Mr. C. A. Wiggins and Mr. W. A. Lamborn prevented the final cataloguing and incorporation of these and many of the earlier series presented by the same kind donor; but all will be completed in the near future and a full account given in next year's Report.

Dr. R. E. Kunzé's valuable donation of insects of many groups from Arizona and of butterflies from California and the North Eastern States will also be dealt with at the earliest possible opportunity. All the specimens have been prepared, but the printed labels have not yet been supplied. Arizona, on the northern borders of the Neotropical Region, is an area of exceptional interest and specimens from it are correspondingly valuable to the student.

Additions to the British Collections in 1910.

The fine collection of British Rhynchota Hemiptera and Homoptera belonging to the late Edward Saunders, F.R.S., was presented by Dr. G. B. Longstaff and the Professor. This, one of the most important additions ever made to the British Collections in the Department, consisted of 17 boxes containing many thousands of specimens determined by this eminent authority in the group. The work upon this collection and its arrangement in cabinet-drawers fell into the present year and will be described in the next Report. It is a pleasure to Oxford zoologists and to the family of the late distinguished naturalist to know that the collection to which he devoted much time and thought is now beside the collections of his father and cousin in the Museum he was ever ready to help.

Another addition to the British Collections—also among the most important ever received—is due to the generosity of Mr. W. Holland, of the Hope Department, who, in 1907,

presented his fine collection of Carabid beetles. The first half of these, containing about 4,400 specimens, was incorporated in 1907 in the first 30 drawers of the rearranged collection of British beetles, and was acknowledged in the Report of that year. The remainder, including about 4,000 specimens, has been placed in the next series of 30 drawers containing the completion of the rearranged *Carabidae*.

Over 850 British flies, chiefly belonging to the family *Dolichopodidae*, but also including many much-needed representatives of several other groups, were presented by Col. J. W. Yerbury, late R.A., F.E.S., F.L.S., F.Z.S. All the species, the great majority of which are very difficult to determine, have been worked out by Mr. G. H. Verrall, Mr. J. E. Collin, and Col. Yerbury himself. The names have been printed and placed on all specimens, and 725 have been catalogued. The material of this most valuable donation was collected by the donor in South Wales (Porthcawl, June) in 1906, and in the following English localities in 1909:—

S. Devon, April (Torcross); Dorset, August (Studland); New Forest, September (Lyndhurst, Brockenhurst, and Holmsley); Cambridgeshire, May (Wood Ditton); Suffolk, May (Mildenhall and Tottington); Essex, July (Clacton-on-Sea, Kirby-le-Soken, and Walton-on-Naze); Kent, June (Dartford).

About 400 British Coleoptera, presented by H. St. J. K. Donisthorpe, Esq., in continuation of his generous gifts in earlier years, have been labelled and catalogued. They include an example of the rare Staphylinid beetle *Emus hirtus* (1910), a mimic of a humble-bee. The actual number catalogued is 380, but often 2 and sometimes 3 specimens on a single mount are included under the same number. Mr. Donisthorpe also presented 66 Rhynchota Hemiptera and Homoptera, and an interesting series of 27 insects of various groups, especially ants and other Hymenoptera, 4 examples illustrating the bionomic relations of insects, and 4 illustrating their means of dispersal in modern times. The latter includes a cockroach introduced in bananas, and beetles imported with plants into the Botanical Gardens at Kew and Dublin.

The specimens were captured by the donor chiefly in 1908 and 1909 in the following counties and districts:—

S. Devon, New Forest, Isle of Wight, Sussex, Kent, Berkshire, Surrey, Middlesex, Essex, Cambridge, Nottingham, Durham, Cumberland, Dumfries, and Inverness.

The British Collections, especially the Lepidoptera, have been greatly enriched during the past year by the kindness of F. C. Woodforde, Esq., B.A., Exeter, who has collected in several localities during 1910 and presented the following fine series of specimens with excellent data:—

From the Bude district, Cornwall (June–Sept.):—140 butterflies, including a fine series of "the Large Blue," *P. arion*; 646 moths; an example of *Asilus crabroniformis* with its Dipterous prey, for the bionomic series.

From N. Wales (1908–10) and the following counties, &c.—Cornwall, Isle of Wight (1900), S. Devon (1897, 1910), Essex (1908), Huntingdon (1899, 1910), Oxfordshire, Staffordshire (1909–10), Shropshire, Cheshire (1908–9), Lancashire (1897, 1904), Westmoreland, Rosshire (1908):—22 butterflies, including 10 *Coenonympha rothliebii* (the "Marsh Ringlet"); 205 moths, including the following interesting Geometers—*Acidalia humiliata* (6), *Ephyra pendularia*, v. *subochreata* Woodforde (2, including the type of the var. described in E. M. M., 1910, p. 114), v. *subroseata* Woodforde (2), *O. bidentata* (2 melanic vars.); and Noctuas—*Nonagria concolor* (4), *Caradrina ambigua* (7), *Epunda lutulenta* (1), *Dianthecia barrettii* (2), *Polia* (*nigrocincta*) *xanthomista* (2), *Acronycta leporina*, bred (2), *Dianthecia conspersa*, a bred series, *Agrotis ashworthii* (4); 13 Hymenoptera; 29 Diptera; 1 Hemipteron; 4 Neuroptera; 3 Orthoptera.

Some of the specimens in the above lists were captured or bred by friends of the donor, and many were bred by him. When no date is mentioned 1910 is to be understood.

Twenty-two Noctuid moths, including a series of *Orthosia suspecta*, from the neighbourhood of Market Drayton (Aug. 2, 1910) were presented by the captor, E. D. Bostock, Esq. Six specimens were added to the general and the remainder to the British collection.

Four examples, 2 males and 2 females, of the bee *Odynerus herrichii* (=*basalis*), from Swanage, June, 1908 and 1909, were presented by the captor, C. M. Mortimer, Esq. An account of this interesting re-discovery is published in the Ent. Monthly Mag., 1908, p. 236, and 1910, p. 1.

A fine series of two species of Phytophaga (Coleoptera) from the Oxford district was presented by the captor, Commander J. J. Walker, Hon. M.A.:—10 *Donacia dentata* on *Sagittaria sagittifolia* near the Wolvercote Paper Mill (July 17, 1909); and 19 *Chrysomela menthastri* on *Mentha* by the Wilts. and Berks. Canal, between Wantage Road and Abingdon (July 2, 1909).

Commander Walker also presented an example of *Vanessa urticae* from which the left hind wing was wanting. The specimen was bred (Oct. 28, 1909) from a larva found at Gosford, near Abingdon.

The voracity of the *Locustidae* is well illustrated by another donation of Commander Walker's—an example of *Thamnotrizon cinerea* (Streatley, Sept. 3, 1910). This insect devoured its own left third leg which had become detached in the box.

A female *Gonepteryx rhamni*, "The Brimstone Butterfly," which had entered a room in No. 4 Norham Gardens, probably intending to hibernate, was captured, Oct. 25, 1909, and presented by H. S. T. Biscoe, Esq.

A large Acarid from the neck of a tortoise at Cambridge (June) was presented by J. E. Collin, Esq., F.E.S. In this and in succeeding donations when no year is mentioned, 1910 is to be understood.

An Ichneumonid from Swanage (August) was presented by the captor, the Rev. W. M. Merry, M.A., Lincoln.

Thirty-seven Coleoptera from Yarmouth, Norfolk (Aug., 1910), were presented by the captor, Mr. A. Cant, F.E.S. The specimens were beautifully mounted by the donor.

The Locustid *Meconema varium* captured in the Pitt-Rivers Department (Oct. 6) was presented by Mr. H. Waters.

Five *Ennomos alniaria*, from the Oxford district, bred in July and August, together with *Toxocampa pastinum* from Cothill (Aug. 7) were presented by Mr. A. H. Hamm.

Mr. J. Collins presented the following insects captured by him in the Oxford district:—

Two examples of *Microdon devius* from Cothill, near Abingdon (June, 1909 and June, 1910): this rare Dipterous insect is an addition to the Oxford district, and was wanting from the collection of British insects; a pair of *Simulium* sp. and of *Harpalus obscurus* from Enslow Bridge (May); 3 co-types of the minute beetle *Enicmus histrio*, described by Dr. Norman Joy in E. M. M., 1910, p. 250, Wytham (April 17), and from the same locality (May 29) 2 Telephorid beetles of different genera, *Telephorus pellucidus* and *Podabrus alpinus*, captured together by sweeping and exhibiting the close superficial resemblance—doubtless Müllerian in character—that is so well known in the family; the Syrphid fly *Chrysochlamys cuprea*, together with the puparium from which it was bred (July 21), Water Eaton.

Mr. Collins also presented 5 Acarids, of at least two species, collected (1909) from S. African cowhides in a tannery at Warrington.

The bee *Anthidium manicatum* captured in the garden of Wykeham House (July 11) was presented by the Professor.

It will be realized from the above account that the British Collections received unusually rich accessions in the course of the year 1910.

In addition to the above, the fine bionomic material especially illustrating the habits and the prey of predaceous insects, collected and presented in recent years by Mr. A. H. Hamm, has not yet been fully labelled and catalogued. In spite of great pressure from many directions it is hoped that this important piece of work may soon be completed and the valuable collection incorporated and acknowledged.

The Hope Library.

The accessions during 1910 were both numerous and important, the fine series of books and memoirs presented by Mr. G. A. James Rothney being especially valuable.

Miss Shelford has unfortunately been unable to continue her efficient help. Mr. F. C. Woodforde has very kindly

assisted the Professor by drawing up lists on which this Report has been largely based; and Mr. R. Shelford has catalogued most of the accessions and written a great part of the following pages.

Donations.

The following publications and Reports were presented :—

Birmingham, Studies from the Zoological Department of the University of, vol. ii, 1910.

Bombay Natural History Society: Journal, vol. xix, pts. 3, 4, 5; xx, 1, 2.

British Museum, Trustees of the :—

Sir G. F. Hampson, Bart.: Catalogue of Lepidoptera Phalaenae, vol. x.

W. F. Kirby: A Synonymic Catalogue of Orthoptera, vol. iii, Pt. II.

Claude Morley, F.E.S.: Catalogue of British Chalcididae.

F. V. Theobald, M.A.: Monograph of the Culicidae, vol. v.

Cambridge University: Forty-fourth Annual Report of the Museum and Lecture-rooms Syndicate.

Chester Society of Natural Science, &c.: Thirty-ninth Annual Report, presented by the Professor.

Colombo Museum, Ceylon: Spolia Zeylanica, vol. vii, pt. xxvi.

Colonial Office, Entomological Research Committe of the :—

Bulletin of Entomological Research, pts. i–iii, 1910.

Instructions to Collectors (Miscellaneous Papers, No. 241).

Hastings and East Sussex Naturalist, vol. i, No. 4.

India, Fauna of British :—

G. J. Arrow: Coleoptera Lamellicornia, pt. i.

W. L. Distant: Rhynchota, vol. v, 1910.

Presented by the Secretary of State for India in Council.

Indian Museum, Calcutta:

Reports for 1908–10. Records, vol. ii, Index; vol. iii, pts. 1–4 and Index; vol. iv, pts. 1–5; vol. v, pts. 1–4. Memoirs, vol. i, No. 4 and Index; vol. ii, Nos. 1–4; vol. iii, No. 1.

Deep Sea Asteroidea, R. Koehler, 1909.

II. The Alcyonarians of the Littoral Area, Thomson, Simpson, and Henderson, 1909.

Illustrations. Mollusca, vi.

List of Beetles, Pt. I, Cicindelinae, Annandale and Horn, 1909.

Instituto Oswaldo Cruz: 1909 and 1910, Rio de Janeiro, Memorias.

Ireland, Department of Agriculture and Technical Instruction for, Fisheries Branch:—

Monograph No. 1, 1908, by Stanley Kemp, B.A.

„ No. 1, 1909, by E. W. L. Holt.

Transferred to the Linacre Department, the author of the 1908 Memoir, on Crustacea, having presented an additional copy to the Hope Library (see p. 27).

London: Local Government Board: Report on Public Health and Medical Subjects (New Series, No. 40).

Michigan Academy of Science: 12th Report, 1910.

Natal Scientific Society, Journal of the: The Naturalist, vol. i, No. 2, 1910.

New South Wales, Department of Agriculture: Five reports on insect pests by W. W. Froggatt.

New York State Museum, Albany: Bulletins 136 and 141.

Ottawa, Experimental Farms of Canada, Reports 1910. Bulletin 66 of the Central Experimental Farm.

Owens College, Manchester: Report of the Manchester Museum, 1909–10.

Radcliffe Library: Catalogue of the Books added to the Library in 1909.

Scottish Commission on Agriculture to Canada in 1908, Report of: 1909.

Smithsonian Institution, Washington: Memoirs on Arthropoda by the following authors:—N. Banks, M. Burr, A. Busck, T. D. A. Cockerell (two memoirs), H. Coutière, D. W. Coquillett, J. C. Crawford, H. G. Dyar, G. C. Embody, J. A. Grossbeck, W. D. Pierce, Mary J. Rathbun, Harriett Richardson (four memoirs), S. A. Rohwer (two memoirs), R. W. Sharpe, R. E. Snodgrass, H. L. Viereck, C. D. Walcott, A. O. Walker, Ada L. Weckel, E. B. Williamson, C. B. Wilson.

The above list includes several fine monographs on Crustacea, and an important paper (by R. E. Snodgrass) on the thorax of the Hymenoptera.

United States Department of Agriculture, Bureau of Entomology: Publications for latter part of 1909 and for 1910, comprising 13 circulars, 21 bulletins, and 4 other pamphlets; also the monthly lists of publications.

The following authors have presented their publications to the Library:—

F. Balfour-Browne, M.A., F.R.S.E., F.Z.S.: Twelve memoirs (1903–9) relating chiefly to aquatic insects.

Jules Bourgeois: Six memoirs on Malacoderm Coleoptera.

G. H. Carpenter, B.Sc., M.R.I.A.: Four memoirs on (1) Subantarctic Collembola, (2) Pycnogonida from Red Sea and Indian Ocean, (3) The Warble-fly of the Reindeer, and (4) Biology—pure and applied.

Hamilton H. Druce, F.L.S., F.E.S.: Descriptions of New Lycaenidae and Hesperiidae from Tropical West Africa (Proc. Zool. Soc. Lond., 1910, p. 356).

James Drummond, F.L.S., F.Z.S.: The Animals of New Zealand, 1909, by Captain F. W. Hutton, F.R.S., and the donor.

A. J. Grove, M.Sc.: Anatomy of "Siphonophora rosarum," part i, 1909, and ii, 1910.

Sir George Hampson: Lepidoptera Phalaenae from Northern Rhodesia. (Proc. Zool. Soc. Lond., 1910, p. 388.)

Stanley Kemp, B.A.: Decapoda Natantia of the Coasts of Ireland (Dep. of Agric. and Techn. Instrn. for Ireland, Fisheries Branch, 1908, No. 1).

Edwin Linton: Helminth Fauna of the Dry Tortugas, II. Trematodes (Carnegie Institution of Washington). This valuable monograph has been transferred to the Radcliffe Library.

R. C. L. Perkins, M.A., D.Sc., Jesus College (Director of the Agricultural Station, Honolulu): Six parts of a memoir on leaf-hoppers, a second memoir on leaf-hoppers (in conjunc-

tion with other authors), and a report on the entomological work of the Hawaiian Sugar Planters' Association (by various authors).

T. Shiraki (Agricultural College, Taihoku, Formosa): Three memoirs on Japanese Orthoptera (one in conjunction with S. Matsumura).

Rev. T. R. R. Stebbing, M.A., Worcester, F.R.S.: Five memoirs on Nomenclature and Crustacea, including Annals of the S. African Museum, vol. vi, part iv, General Catalogue of S. African Crustacea (Pt. V of S. A. Crustacea).

Rev. Father Wasmann, S.J.: Sixteen memoirs on ants and termites.

Dr. Fr. Zacher (University of Breslau): Three memoirs on Forficulidae.

Original papers have also been presented by the following authors:—Dr. N. von Adelung, of the Zoological Museum, Imperial Academy of Sciences, St. Petersburg (three memoirs); Dr. N. Annandale, Superintendent of the Indian Museum, Calcutta; Eustace R. Bankes, M.A., F.E.S.; Dr. F. A. Bather, F.R.S.; Professor T. Hudson Beare, F.E.S.; Professor Lawrence Bruner of University of Nebraska; Dr. Malcolm Burr, M.A., D.Sc. (New College), F.L.S., &c. (two memoirs); Vicomte R. du Buysson of Paris Museum; Dr. T. A. Chapman, M.D., F.Z.S., &c.; L. Chopard (two memoirs); Dr. H. Dohrn, of Stettin Museum (two memoirs); Herbert Druce, F.L.S. (two memoirs); H. Eltringham, M.A., F.Z.S., F.E.S.; Lieut.-Colonel J. Malcolm Fawcett; T. Bainbrigge Fletcher, R.N., F.E.S.; Dr. R. Gestro of Genoa Museum; Dr. A. Griffini, of Reale Istituto tecnico di Bologna (three memoirs); Dr. R. R. Gurley, M.D., M.Sc.; A. H. Hamm (two memoirs); Dr. C. Gordon Hewitt; Dr. Karl Jordan, Ph.D., &c. (three memoirs); E. G. Joseph, B.Sc., Lincoln, F.E.S.; Professor Chancey Juday; Professor J. Graham Kerr, F.R.S.; Dr. G. B. Longstaff, M.A., D.M., New College; J. R. Malloch; S. A. Neave, M.A., B.Sc., Magdalen (two memoirs); H. Rowland-Brown, M.A., University, F.E.S.; C. Schaeffer; W. Schaus (three memoirs); Dr. A. von Schulthess Rechberg of Zurich

(four memoirs); R. Shelford, M.A., F.L.S. (four memoirs); J. W. Shoebotham; C. J. Wainwright, F.E.S.; Professor W. M. Wheeler of Harvard University.

Valuable additions to the Library have been presented by the following donors:—

Malcolm Burr, M.A., D.Sc., New College, F.L.S., &c.: one memoir by H. Dohrn, one memoir by A. Borelli, two memoirs on Bombidae by A. S. Skorikoff.

Dr. G. B. Longstaff, M.A., D.M., New College: the following volumes:—Evolution and Adaptation, T. H. Morgan (1908), Manual of New Zealand Entomology, G. V. Hudson (1892), New Zealand Neuroptera, G. V. Hudson (1904), and Guide to the Study of Australian Butterflies, W. J. Rainbow, F.L.S.

Professor R. Meldola, Hon. D.Sc., F.R.S., Grundzüge der Zoologie, Vols. I and II, C. Claus, 1880–2.

G. A. J. Rothney, F.E.S.: Transactions of the Entomological Society, London, for 1908 and 1909.

Hon. Walter Rothschild: The parts of the Novitates Zoologicae of the Tring Zoological Museum, published in the year 1910.

R. Shelford, M.A., F.L.S.: one memoir on Myriopoda by F. Silvestri, one memoir on Bornean Rutelidae by G. J. Arrow, one memoir on a fossil Arachnid by E. L. Gill, one memoir on Japanese Locustidae by S. Matsumura and T. Shiraki, two memoirs by R. P. Longinos Navas, S.J.

The Professor:

A bound volume of 38 original papers on Eastern Lepidoptera (1857 to 1869) presented by Dr. Alfred R. Wallace to the Professor was given by him to the Library.

The publications of the Société Entomologique de France for 1910, and of the Société Entomologique de Belgique for 1910, the publications of the Linnean Society for 1910, the Transactions of the Entomological Society of London for 1910, the Journal of Economic Biology, Vol. V (1910), Boletín IX, 1910, and Vol. VI of the Memorias de la Real Sociedad Española de Historia Natural.

The Rothney Library of works on the Hymenoptera, &c.

In addition to numerous unbound separata on Hymenoptera by Cameron and Forel and sets of the numbers of various valuable journals, a series of 92 volumes contains the following important accessions. The few duplicates in the list will be useful to workers in the Department.

W. Ashmead : Classification of Ichneumon Flies, 1900.

C. T. Bingham : 2 volumes on the Hymenoptera of British India ; 1 of papers on Oriental Hymenoptera.

P. Cameron : 11 volumes of collected papers on Oriental Hymenoptera—largely those of the Rothney Collection.

Desvignes : British Ichneumonidae in the British Museum, 1856.

A. Forel : 3 volumes of collected papers on Indian and Australian Ants.

Jerdon, 1835, 1851 ; Sykes, 1835 : 3 rare publications on Indian ants, bound in two volumes of papers.

Mayr : Memoir on the Ants of the Rothney Collection, 1878.

G. A. J. Rothney : 14 volumes of published papers, correspondence, and notes, chiefly on Indian Hymenoptera and Lepidoptera.

E. Saunders : British Hymenoptera Aculeata.

F. Smith : 10 volumes (including collected papers) on Hymenoptera, one written in collaboration with C. Horne.

Wroughton : Our Ants, 1891 ; Walsh : Spiders mimicking ants, 1891 ; Doherty : on Oriental Butterflies, 1891, bound in one volume with other papers from the Bombay Natural History Society and the Asiatic Society of Bengal.

Among the volumes not specially relating to the Hymenoptera are the following:—

A. G. Butler : New Species of Sphingidae, 1875.

Hewitson and Moore : New Indian Lepidoptera, 1879.

Douglas : World of Insects, 1856.

Ingpen : Butterfly Collecting, 1839.

Kirby and Spence's Entomology, 1865. This edition is wanting from the library of the Department.

R. Shield: Practical Hints respecting Moths and Butterflies, 1856.

Stainton's Manual, 1857.

In addition to this splendid addition to the section of the Hope Library devoted to the Hymenoptera, the generous donor several years ago presented a fine series of bound volumes of the Entomological Society's publications and has ever since presented the annual volumes, bound.

Exchanges.

The parts of the following journals for the year 1910 were received in exchange for the Hope Reports:—

Deutsche Entomologische National-Bibliothek.

Deutsche Entomologische Zeitschrift.

Entomologisk Tidskrift, Stockholm.

Bulletin de la Société Entomologique Suisse.

Purchases.

The following publications of the year 1910 were purchased for the Department:—The volume of the Ray Society, of the Zoological Record, the numbers of the Entomologist's Monthly Magazine, the Entomologist, and the Entomologist's Record.

In addition to these regular purchases there was also bought:—A Natural History of the British Lepidoptera, Vol. X, by J. W. Tutt.

E. B. POULTON.

Report of the Hope Professor of Zoology, 1911.

The Report for 1911 has been prepared under exceptionally difficult conditions. The collections of Lepidoptera were transferred to the south end of the old Radcliffe Library early in the present year, and advantage was taken of this rearrangement to reorganize the whole of the rest of the collections, and to lay down cork carpet upon all the parts of the old Department except the Library, which has been thus covered for many years. With the pressing necessity for other work this rearrangement could only be effected a part at a time; and, at the present moment, immense masses of material, temporarily stored in the old Library while the linoleum was being fitted, still await rearrangement. As one result of the confusion a large number of the duplicate labels from which the Report is written have been for the time misplaced, and will only be found when the material is redistributed in its place. Further difficulties have followed from Mr. Shelford's illness, and the fact that his successor, Mr. R. S. Bagnall, has not yet been able to begin his work.

Under these circumstances the details of a large part of the accessions in 1911, although incorporated, can only appear in next year's Report.

1. *The Rothney Collection of Hymenoptera.*

Mr. G. A. James Rothney has in the course of 1911 presented three important collections, which have now been supplied with printed labels and placed in drawers at the end of the cabinet of Oriental Hymenoptera presented by him in 1910 and acknowledged in last year's Report.

The three collections are:—(1) African, Madeiran, and Madagascan Hymenoptera from Hermann Rolle; (2) Malayan Hymenoptera (principally Javanese) from the Van der Poll collection; and (3) a collection, chiefly of Hymenoptera, made by F. P. Dodd in N. Australia.

Details of the numbers, which are very large, will appear in next year's Report. The localities in which these collections were made render the accessions of great interest and value.

2. *Additions to the Collection of Lepidoptera from Equatorial Africa.*

It has been already explained that the Catalogue for 1911 is unavoidably incomplete, and it is therefore necessary to make special mention of the very large additions to the University collection of Lepidoptera from Equatorial Africa.

The material is all of the greatest interest, because of the very full and exact data of time and place by which it has been accompanied. Furthermore, its interest is greatly increased by the fact that it has been sent by naturalists residing at different points on the equatorial zone crossing the Continent—by Mr. W. A. Lamborn in the Lagos district of S. Nigeria on the West Coast; by Mr. C. A. Wiggins in the Entebbe district; by Mr. G. D. H. Carpenter, B.M., Non-Coll. on the islands in the north-west part of the Victoria Nyanza; and by the Rev. K. St. Aubyn Rogers, M.A., Wadham College, in the Mombasa district on the East Coast. Even where two localities are as near together as Entebbe and Damba Island, only 20 miles distant, in the Lake, specimens from the one gain greatly in interest by their relations to those from the other.

3. *Additions to the British Collections.*

It is also necessary to allude briefly to the very great additions to these collections in 1911, owing to the gift by Mr. W. Holland of the remainder of his fine collection of British Coleoptera, especially from the Oxford district, by Mr. A. H. Hamm of the splendid set of specimens bearing upon the natural history of the Empidae, and throwing great light upon their habits in securing prey and in courtship, by Mr. F. C. Woodforde, of a fine series of Lepidoptera collected in 1911, and by Col. Yerbury and Mr. H. Donisthorpe of further important additions to the collections of Diptera and Coleoptera respectively.

4. *Work done by the Staff.*

Although the actual transference of cabinets into the new space did not begin until January 22 of the present year,

a large amount of the work in 1911 was undertaken in preparation for this great event in the history of the Hope Department. Thus, Mr. W. Holland, in addition to the constantly recurring incorporation of specimens, spent much time in making a list of the whole of the collections which has been of much service in the rearrangement now being effected. Another very important piece of work begun and completed by him in 1911 was the preliminary arrangement of all the material in the General Collections of Rhynchota, both Hemiptera and Homoptera, and the careful and complete arrangement of the British Collections of the same group. These latter, after receiving distinctive labels, were united into a single great collection of which the central feature is the fine series of specimens which formed the private collection of the late Edward Saunders, F.R.S., and all determined by him. Mr. Holland also expended much time upon the Baden-Sommer Collection of Coleoptera presented by the Professor in 1911; and in the preliminary arrangement of certain groups of moths.

Mr. A. H. Hamm, in addition to the large amount of labour expended in setting the accessions, especially those received from Equatorial Africa, was able to devote much time to printing labels, to incorporating large numbers of specimens in the British Collections of Diptera, and, by re-setting the *Erycinidae*, to completing the readjustment of the general collection of butterflies. Some of the printing, especially that required by the S. A. Neave and the C. A. Wiggins Collections, as well as by the great collections of *Empidae* and their prey presented by Mr. Hamm himself, was very extensive.

The chief work carried out by Mr. Joseph Collins has been printing for and labelling the great West African collection, chiefly of Lepidoptera, presented by Mr. W. A. Lamborn. The reproductions in the labels of the precise and admirably full data recorded by the donor has involved an immense amount of exacting work, as well as much time spent in the preparation of forms of label and in supervision by the Professor. Among other large pieces of work have been labelling the remainder of the S. A. Neave and C. A. Wiggins Collec-

tions and the *Empidae* presented by Mr. Hamm, and labelling as well as printing for the accessions to the British Collections presented by Col. Yerbury, Mr. H. Donisthorpe, and Mr. F. C. Woodforde.

A large piece of work which was taken up again and again in the intervals between others was the labelling of the Baden-Sommer Collection containing nearly 50,000 Coleoptera.

5. *Work on the Collections of Orthoptera.*

Mr. Shelford's illness compelled him to give up the post of Assistant Curator at the end of 1911. It is greatly to be regretted that his fine work upon the Hope Collections of Orthoptera has thus come to an end. It is very much to be hoped that at some future time he may be able with recovered health to revisit the Department, and again study the collections which he has done so much to increase and bring into their present excellent condition. In spite of his illness and absence from Oxford, Mr. Shelford was able to do work of great value to the Department by looking over and correcting a long series of tables, and by cataloguing accessions. The titles of papers published by him in 1911 appear on p. 978.

6. *Work on the Collection of Pierinae.*

Dr. F. A. Dixey has been occupied in extending his investigations on the subject of the scent-distributing apparatus in Lepidoptera. These formed the subject of a Friday evening Discourse at the Royal Institution of Great Britain, and of a paper and demonstration at the meeting of the British Association at Portsmouth. He has also worked out the *Pierinae* in several interesting collections, including one from the Mediterranean Sub-region (P. de la Garde), and others from Nigeria (J. J. Simpson), German East Africa (Entomological Research Committee), and Australia (G. A. Waterhouse). The latter included authentic specimens of the rare Pierine *Tachyris melania*, which since its description by Fabricius in 1775 has been almost unknown to entomologists. These were exhibited at a meeting of the Entomological

Society of London, and a notice of them was communicated to the "Proceedings" (see p. 977). Several interesting species new to the collection have been incorporated by Dr. Dixey, including *Hesperocharis gayi*, Blanch., *Colias romanovi*, Grm. Grsh., and *C. staudingeri*, Alpher., *Pontia leucodice*, Eversm., *Delias lara*, Boisd., *D. ladas*, Gr.-Smith, *D. bakeri*, Kenr., and *D. rothschildi*, Kenr.

7. *Work upon the Collection of Acraeinae.*

Mr. H. Eltringham, M.A., New College, continued his work upon the African Acraeas. His study of the group has been so complete and so penetrating that when he visited Berlin, in the summer of 1911, every conclusion he had formed beforehand concerning the German types was found to be correct. The preparation of his monograph, which is now going through the press, involved the making, chiefly in 1911, of nearly 500 drawings for the plates. Mr. Eltringham paid many visits to the Natural History Museum and revisited the Tring Museum in order to make a second examination of the Acraeas. In addition to the work upon this fine monograph, to be issued in the present summer by the Entomological Society of London, Mr. Eltringham began to draw the plates for the *Acraeinae*, in Wytsman's "Genera Insectorum" (Brussels), a work in which he is co-operating with Dr. Karl Jordan of Tring. Two papers on Acraeas published by Mr. Eltringham in the course of 1911 are referred to on pp. 977, 978.

8. *Rearrangement of the British Beetles.*

During the past year Commander J. J. Walker has continued to give kind help in the rearrangement of the British (Hope-Westwood) collection of Coleoptera. The *Staphylinidae*, which were in progress at the time of last year's Report, are now completed, all the specimens which were in a condition to be remounted having been cleaned and repinned or carded with, on the whole, satisfactory results. The *Scydmaenidae* and *Pselaphidae*, of which families there are a large number of specimens and some rare and interesting forms, were then proceeded with, and these being

nearly all carded, and in sound condition, have made excellent examples. Finally, a commencement has been made with the family *Anisotomidae*, which is now in progress and nearing completion.

9. *Assistance in Working out the Material of the Department.*

Both Mr. C. A. Wiggins and Mr. W. A. Lamborn paid long visits to Oxford in the course of the year, and were able to afford very important assistance in working out the great collections which they have presented. Mr. Lamborn accompanied the Professor in several visits to the Natural History Museum and helped to determine numbers of specimens in his collection, especially the moths. In Oxford he very kindly helped in the verification of the labelling of his specimens and in their arrangement in groups. In consequence of this work Mr. Lamborn was able, after his return to the Lagos District in July, to study the problems presented by the Lepidoptera and other insects with far greater success. During his visit home he also exhibited the specimens collected by him at the two soirées of the Royal Society and at that of the Entomological Society, and read an account of some of his observations at a meeting of the latter society.

Mr. Wiggins also exhibited on the same occasions, and in Oxford worked through the whole of his large collection, and prepared a tabular statement of all the models and mimics in the collections sent by him from Entebbe since May 23, 1909. These statements will appear in a joint paper by him and the Professor, to be communicated to the Entomological Congress in August of the present year.

Dr. Karl Jordan gave most kind assistance in determining the material of the Department in the groups of which he has made a special study. This help was partly given at Tring, and partly during his visits to Oxford.

Col. J. W. Yerbury has, as in former years, given the kindest help in the arrangement of the collection of Diptera, coming to Oxford for this special purpose from March 6 to 28.

Much kind help has also been rendered by the members of the staff of the Insect Department of the British Museum (Natural History); by Mr. Hamilton Druce; and by Mr. G. T. Bethune-Baker.

Dr. R. C. L. Perkins, M.A., D.Sc., Jesus College, in the course of a too brief visit to the Department, examined the Australian Hymenoptera presented by Mr. Rothney.

10. *Visits of Naturalists.*

The postponement of the time when the Department could expand into the new room and the resulting congestion in the old quarters prevented the usual meeting of entomologists from being held in the summer of 1911. The Department was, however, visited by a large number of naturalists, among whom were many generous donors of specimens or of help in working out the material. It was a great pleasure to show Mr. G. A. James Rothney his beautiful collections of Oriental and British Hymenoptera which reached the Department in perfect condition in 1910, together with the large accessions presented by him in 1911. Mr. Guy A. K. Marshall and Mr. J. C. Kershaw have also seen something of the collections they have in former years done so much to enrich. The visits of Mr. C. A. Wiggins and Mr. W. A. Lamborn have been mentioned in the previous section. Other kind donors of valuable material who have visited the Department are—Dr. F. W. Andrewes, D.M., Ch. Ch.; Mr. E. A. Elliott, F.Z.S., F.E.S.; Mr. F. W. Lanchester, M.A., and Professor E. A. Minchin, M.A., Keble College, F.R.S. It was a pleasure to show to Mr. A. A. Saunders, M.A., Keble College, the fine collection of British Rhynchota which had belonged to his father, the lamented naturalist, Edward Saunders, F.R.S. Mr. Geoffrey Meade-Waldo, M.A., Magdalen College, and Mr. J. Hartley Durrant, who have assisted the Department by working out its material, have also visited us, together with the following naturalists who have assisted the Department by the gift of specimens as well as by advice and work—Mr. G. C. Champion, Mr. W. J. Lucas, B.A., F.E.S., and Mr. Rowland E. Turner.

Dr. G. B. Longstaff, in the preparation of his book "Butterfly-hunting in many lands", published in 1912, has paid visits in order to study the fine collections presented by him to the University. Mr. W. B. Alexander, B.A., King's College, Cambridge, who has continued the Prout-Bacot experiments on the moth *Acidalia virgularia*, has come to study the original material. Mr. Alexander has now published his results (Proc. Roy. Soc. B, vol. 85, 1912, p. 45) and placed his specimens with the original material in the Hope Department. Mr. Hugh Scott, M.A., Trinity College, Cambridge, Mr. G. Arnold, M.Sc., of the Bulawayo Museum, and Mr. James H. Keys have also visited the Department. Mr. D. Jenness, B.A., Balliol College, paid a brief visit in order to learn something of the problems to be studied in the Papuan area which he was about to visit.

The Department was also visited by Sir David Bruce, F.RS., and Lady Bruce; Professor Charles Ferrière of Geneva; Professor J. Stanley Gardiner, F.R.S.; Professor W. Garstang; Dr. W. H. Gaskell, F.R.S.; Sir Archibald Geikie, P.R.S.; Professor Sydney J. Hickson, F.R.S.; Sir E. Ray Lankester, F.R.S.; Professor C. S. Minot, Hon. D.Sc., of Harvard University; Professor R. C. Punnett, F.R.S.; Dr. G. Archdall Reid; Professor C. Sasaki, Imperial University of Tokyo; and Professor G. Elliott Smith, F.R.S.

II. *Works published in* 1911.

The following papers appeared in the Transactions of the Entomological Society of London for 1911:—

Pt. I, No. I.—On the Forms and Geographical Distribution of *Acraea lycoa*, Godt., and *Acraea johnstoni*, Godm., by Harry Eltringham, M.A., F.Z.S.

Pt. I, No. VI.—Experiments in 1909 and 1910 upon the Colour-relation between Lepidopterous Larvae and Pupae and their Surroundings, by Elizabeth Bridges.

Pts. III and IV, No. XXIII.—South African Aculeate Hymenoptera in the Oxford Museum, by the late Col. C. T. Bingham, F.Z.S., with an Introduction by the Professor.

The following short papers, or brief descriptions of the material of the Department exhibited at the meetings of the Entomological Society of London in 1911, have been published in the Proceedings:—

June 7, 1911, p. xxx. Hemipterous mimics of Hymenoptera, by A. H. Hamm.

June 7, p. xxxiii. Family bred by G. F. Leigh, containing a new female form, *leighi*, bred from a *trophonius*, Westw., female of *Papilio dardanus cenea*, Stoll, from Pinetown, Natal.

June 7, p. xlii. *Papilio dardanus*, Brown, female form *planemoides*, Trim., sent by Rev. K. St. Aubyn Rogers, from the Coast of British East Africa.

June 7, p. xliv. Heredity in the female forms of *Hypolimnas misippus*: results recently obtained by Rev. K. St. Aubyn Rogers.

June 7, p. xlv. *Euralia anthedon*, Doubl., and *E. dubia*, Beauv., proved by the breeding experiments of W. A. Lamborn to be the forms of a single species.

June 7, p. xlvi. Instances of Mimicry, Protective Resemblance, &c., from the Lagos district, by W. A. Lamborn.

October 4, p. liii. Separation of the sexes in *Hypolimnas misippus*, by Dr. F. A. Dixey, F.R.S.

October 4, p. liv. The Cocoons of *Deilemera antinorii*, Oberth., formed by larvae bred by W. A. Lamborn in the Lagos district.

October 4, p. liv. All-female batches of *Acraea encedon*, L., bred by W. A. Lamborn in the Lagos district.

October 4, p. lvi. G. D. H. Carpenter's proof, by breeding, that *Acraea aurivillii*, Staud., is the female of *A. alciope*, Hew.

October 18, p. lix. *Papilio* (*Tachyris*) *melania*, Fabr., by Dr. F. A. Dixey.

Nov. 1, p. lxv. African species of *Acraea*, by H. Eltringham, M.A., New College.

Nov. 15, p. lxxii. C. F. M. Swynnerton's observations on Rhodesian insects and their enemies.

Nov. 15, p. lxxiii. Instances of Mimicry exhibited by

certain Sarawak insects, by J. C. Moulton, with an appendix containing descriptions of new forms, by C. J. Gahan.

Nov. 15, p. lxxx. A new Lycaenid mimic of *Acraea anemosa*, captured by S. A. Neave in German East Africa.

Nov. 15, p. lxxxi. G. D. H. Carpenter's proof, by breeding, that *Acraea orestia* and *A. humilis* are two forms of a single species, by H. Eltringham.

Nov. 15, p. lxxxi. The relationship between *Acraea circeis* and *A. servona*, by H. Eltringham.

Dec. 6, p. lxxxix. Contrasts in colouring between certain species of butterflies from the Lagos district and their geographical races at Entebbe, by the Professor.

Dec. 6, p. xci. Pseudacraeas of the *hobleyi* group collected by G. D. H. Carpenter on Damba Island, as compared with those collected by C. A. Wiggins in the Entebbe district, by the Professor.

Dec. 6, p. xcv. W. A. Lamborn's observations on the courtship of *Planema alcinoe*, Felder.

Dec. 6, p. xcv. The cocoons and eggs of the Bombycid moth *Norasuma kolga*, Druce, collected by W. A. Lamborn.

Dec. 6, p. xcvi. W. A. Lamborn's and G. F. Leigh's observations on the spherical bodies on the cocoons of the Hypsid moth *Deilemera antinorii*, Oberth.

Dec. 6, p. xcviii. The spherical bodies on the cocoons of the Tineid genus *Marmora*, by the Professor.

Dec. 6, p. xcix. W. A. Lamborn's observations on the attacks of Tachinid flies upon the African Danaine genus *Amauris*.

Dec. 6, p. xcix. Some ant-tended Lycaenid larvae observed by W. A. Lamborn in the Lagos district.

Dec. 6, p. civ. W. A. Lamborn's observations on *Coccidae* as the food of the carnivorous Lycaenid larva *Spalgis lemolea*, H. H. Druce.

The following papers appeared in the volume of memoirs issued (Brussels, 1911) by the "1^er^ Congrès International d'Entomologie":—

Mimicry, by Dr. F. A. Dixey, D.M., Wadham College, F.R.S., p. 369.

On Dr. C. A. Wiggins' Researches on Mimicry in the Forest Butterflies of Uganda (1909), by the Professor, p. 483.

The following papers appeared in the *Entomologist's Monthly Magazine* for 1911 (vol. 47):—

Three Weeks in the Sudân, by G. B. Longstaff, D.M., F.R.C.P., &c., pp. 119–127 and 194–202.

British Orthoptera in the Dale Collection, I. Earwigs, Cockroaches, and Crickets, by W. J. Lucas, B.A., F.E.S., pp. 135–138.

Preliminary Diagnoses of some new Genera of *Blattidae*, by R. Shelford, M.A., F.L.S., pp. 154–156.

Notes on the early stages of *Haemonia appendiculata*, Panz., by Joseph Collins, pp. 248–250.

The following papers appeared in the publications referred to:—

Preliminary descriptions of some new or little-known forms of the genus *Acraea*, by Harry Eltringham, M.A., New College. Nov. Zool., xviii, Sept., 1911, p. 149.

On the Lepidoptera Rhopalocera collected by W. J. Burchell in Brazil, 1825–1830, VIII. *Acraeinae*, by E. G. Joseph, B.Sc., Lincoln College. Ann. and Mag. Nat. Hist., Ser. 8, vol. vii, Jan. 1911, p. 9.

Description of some new species of *Blattidae*, by R. Shelford, M.A., F.L.S. Ann. and Mag. Nat. Hist., July, 1911, p. 1.

On the Palatability of some British Insects, with notes on the significance of mimetic Resemblances, by R. I. Pocock, F.R.S., F.L.S., F.Z.S. With Notes upon the Experiments, by the Professor. Proc. Zool. Soc. Lond., 1911, p. 809.

12. *Eighth Volume of Hope Reports.*

It is intended to issue this volume as soon as Mr. H. Eltringham's monograph on the African *Acraeinae* is published. It may be possible at the same time to bring out the first volume of a series containing papers of a larger size, and perhaps of one containing still larger papers.

Additions to the Collections in 1908.

A fine collection of 297 Coleoptera and a few other insects

from Piroe, on the SW. coast of Ceram (0–2,000 ft.), was presented by the captor, J. C. Kershaw, Esq. The specimens were collected (Jan.–Apr., 1908) in a heavily forested hilly district.

ADDITIONS TO THE COLLECTIONS IN 1910.

Nearly the whole of the valuable collection of insects from Arizona collected and presented by Dr. R. E. Kunzé has now been labelled, catalogued, and incorporated. The collection includes 196 insects (1908–10) from Phoenix, in the valley of the Salt River, southern Arizona (1,100 ft.); 167 insects (1907–1910) from Prescott, in western Arizona; and 8 Lepidoptera (1908) from Senator, Upper Hassayampa River (7,000 ft.), near Prescott. The two larger series chiefly consist of Lepidoptera, but also contain a large number of Hymenoptera and many fine Orthoptera. Among the butterflies are 9 *Limenitis* (*Basilarchia*) *hulsti*, 6 *L.* (*B.*) *astyanax*, 2 *Adelpha californica*, and 5 *Papilio daunus*. The position of Arizona on the borders of the Neotropical Region makes its fauna of high interest, and the University collections have been greatly enriched by Dr. Kunzé's generous gifts acknowledged here and on p. 979.

A valuable series of 105 butterflies bred in 1909 and 1910 from ova or larvae obtained in the Durban district, together with 9 pupal cases, was presented by the late A. D. Millar, Esq., of Durban, whose sudden death last year was a grievous blow to the study of natural history in South Africa. The collection includes 46 specimens of the splendid *Acraea* mimic, *Pseudacraea trimenii*, 35 of the even more perfect mimic *Ps. imitator*, 13 of the Natal form of *Ps. lucretia*, mimicking the Danaine butterflies *Amauris echeria* and *A. albimaculata*, 11 *Lachnoptera ayresi*. Of the pupal cases 6 were of the last-named species, 2 of the Pierine *Mylothris trimenia*, and 1 of the Hesperid *Artitropa erinnys*. The fine series of *Ps. trimenii* is of especial interest, for the individuals exhibit marked variation in the features by which the pattern of the western subspecies, *Ps. boisduvali*, mimetic of *Acraea egina*, is distinguished from that of the eastern *Ps.*

trimenii, mimetic of *A. zetes acara.* The range and amount of variation shows how easily the one form could be derived from the other.

Nine Lepidoptera collected in various localities in S. Nigeria (1910) by Dr. J. J. Simpson were presented by the Entomological Research Committee of the Colonial Office.

Additions to the Collections in 1911.

The comparative brevity of the following account of the accessions in 1911 is explained in the opening paragraph of this report.

The following valuable African collections have been presented by the Entomological Research Committee of the Colonial Office. The three collections first named were made by the Committee's Travelling Entomologist in East Africa, S. A. Neave, Esq., M.A., B.Sc., Magdalen College. All the specimens are accompanied by the admirably full and precise data invariably recorded by Mr. Neave.

(1) A series of 66 butterflies from Nyasaland and German East Africa (1910). The series includes 3 examples of *Amauris ansorgei* new to the collection, a fine female of *Planema epaea*: 2 examples of a splendid new Lycaenid, mimetic of the pattern of *Acraea anemosa.* This wonderful new form, shortly to be described as a new species of a new genus and named *Sheffieldia* after the captor by Mr. H. H. Druce, is a most remarkable addition to the numerous mimetic Lycaenids of Africa. The whole of this series of butterflies is of the utmost value to the Collection, which is rich in specimens from the areas both to the north and to the south of German East Africa, but very poor in representatives from the territory itself.

(2) An interesting set of 48 butterflies, collected Feb. and March, 1911, in British East Africa, chiefly on the slopes of Kenia and on the Aberdare Range. The series includes a fine set of *Acraea baxteri* and of *A. excelsior,* as well as males and a female of *Acraea disjuncta* and 2 butterflies exhibiting

injuries (observed during life), probably caused by the attacks of enemies. Most of the specimens were captured at an elevation of from 6,000 to 8,500 feet.

(3) Forty-eight butterflies collected (April–June, 1911), near the western boundary of British East Africa, in Kavirondo and on the southern foot and slopes of Mt. Elgon. The series includes the following interesting species, the first of which is barely represented in the collection, while all are greatly wanted for the sake of the locality:—8 *Acraea unimaculata*, 4 *A. asboloplintha*, 4 *A. admatha leucographa*, 4 *A. equatorialis*, 2 *A. johnstoni*, 7 *Planema latifasciata*, 3 *Mimacraea marshalli*, 3 *Belenois raffrayi*.

(4) Fourteen Lepidoptera from various localities in N. Nigeria, collected by Dr. J. J. Simpson, Travelling Entomologist in West Africa. The specimens, although not of any great rarity, were an interesting addition to the collection on account of the admirable data both of time and place. In addition to the butterflies 2 examples of the extraordinary and problematical insect, *Pseudopontia paradoxa*, were included.

(5) A valuable series of named African Diptera, including species of Tsetse-fly (*Glossina*) and *Tabanidae*. Of these, 214 specimens were catalogued as permanent accessions. In addition to the Diptera over 400 Hymenoptera belonging to many groups, 38 Coleoptera, 2 Odonata, and 7 Orthoptera were also presented by the Committee. All the specimens other than Lepidoptera were labelled and named in the Natural History Museum under the supervision of Mr. Guy A. K. Marshall, the Scientific Secretary to the Committee.

The following families of butterflies from the Lagos district bred by W. A. Lamborn, Esq., M.R.C.S., L.R.C.P., have been catalogued and incorporated:—

(1) The Nymphaline butterfly *Kallima rumia*: the female parent and offspring, together with the pupal cases of a large number, 122 specimens.

(2) A female parent of the mimetic form *hippocoon* of *Papilio dardanus*, together with its offspring, 15 males and 14 females.

(3) A second parent with its offspring, 18 males and 13 females.

(4) A third parent with its offspring, 13 males and 10 females.

Many pupal cases from which the offspring had emerged are also included. All the female offspring in the three families of *dardanus* were *hippocoon*, thus contrasting in a very striking way with the families bred from the same mimetic form in the Durban district. Small differences between the parents, such as the size of the large white patch of the hind-wing, or the size and shape of the small spot in the cell of the fore-wing, appeared in a large proportion of the offspring in the respective families.

Sixteen insects from the Lagos district were presented by W. H. Hayman, Esq. The series includes *Papilio zalmoxis* and 6 examples of the Tabanid *Chrysops silacea*, the worst biting fly of the locality.

The following valuable specimens were presented by S. A. Neave, Esq., M.A., B.Sc., Magdalen College, having been received from museums or naturalists to whom duplicates from the Neave Collections had been sent:—

(1) A fine set of 31 Acraeine butterflies from various localities (1883–96) in Madagascar, chiefly collected by the brothers Perrot. These specimens were received from M. Charles Oberthür of Rennes. The particulars both of time and place are as detailed and admirable as in all specimens from the Oberthür collection, and the donation is a fine addition to the large collection of *Acraeinae*, in which the Hope Department, although rich in African material, is poor in species from Madagascar.

(2) Thirty-two Lepidoptera, including 8 butterflies collected in the Kilimanjaro district by the Sjöstedt Expedition, were sent by Professor Chr. Aurivillius of Stockholm. The species, which had been named by Professor Aurivillius, included a male of *Papilio sjöstedti*, a very interesting form new to the Hope Collections. Professor Aurivillius also presented

a female example of *Acraea medea*, from Prince's Island in the Gulf of Guinea. This interesting butterfly, which is extremely rare in collections, is considered by Mr. H. Eltringham to be an island form of *A. egina*.

(3) Thirteen butterflies from different localities in the north-east of German East Africa were received from the Berlin Natural History Museum. The collection consisted of a valuable series of *Acraeinae*, together with one example of the extremely interesting Nymphaline butterfly, *Catuna sekorana*, new to the Hope Collections.

A very fine male example of *Tirumala* (*Melinda*) *morgeni*, from the Ja River, Cameroons (1909), was presented by H. Eltringham, Esq., M.A., New College. This is only the second example in the Department of this most interesting mimetic butterfly, the previous specimen having been presented a year or two ago by the Hon. Walter Rothschild, F.R.S. The great interest of the specimen is that it shows the influence of the local Ethiopian Danaine pattern, as represented in the genus *Amauris*, upon an Oriental invader, arriving from the East and finally penetrating to the West coast. The invader has now given rise to three different species, of which the eastern, *T. formosa*, is still Oriental in appearance, the central species, *T. mercedonia*, has become much darker, while the third, *T. morgeni*, from the West coast, has, superficially, precisely the appearance of a black and white African *Amauris*.

A set of 12 Acraeas from Ukerewe Island, in the SE. of the Victoria Nyanza, and 4 from Kigonsera, near the NE. shore of Lake Nyasa, were, through the kindness of H. Eltringham, Esq., M.A., New College, presented by Herr J. N. Ertl.

A series of 6 examples of the Pierine butterfly *Euchloe charlonia*, from Lanzarote, Canary Islands (300 ft.), was presented by E. A. Elliott, Esq., F.E.S., F.Z.S. The specimens were captured at Haria in 1903 by Fairfax Prevost, Esq. The occurrence of this African form in the Canary Islands is of great interest.

Fifty-one Lepidoptera from Grand Comoro, 39 from Johanna, and 26 from Mayotta (all 1911), were purchased from the captor, G. F. Leigh, Esq., F.E.S., of Durban. All the specimens are accompanied by precise dates.

A splendid collection of over 2,000 Coleoptera from various localities in Arizona was presented by the captor, Dr. R. E. Kunzé, of Phoenix. The specimens were collected in the following localities:—Phoenix (1897–1907)—1,220 specimens; Pinal Mts., Globe, S. Arizona (July 1–Aug. 16, 1900), 4,000 ft. —117 specimens; Nogales, S. Cruz Co., S. Arizona (May 20–June 16, 1899), 4,000 ft.—22 specimens; Tucson, S. Arizona (Apr. 15–May 8, 1896), 2,200 ft—162 specimens; Huachuca Mts., S. Arizona (June 18–Sept. 15, 1899), 7,000–8,000 ft.—237 specimens; Prescott, W. Arizona (1896–1906)—265 specimens; Senator, Upper Hassayampa River, ten miles S. of Prescott (1896–1903), 7,000 ft.—39 specimens.

A valuable collection of 434 butterflies from Queensland, chiefly from the N. coast (1904), was presented by the captor, Dr. R. C. L. Perkins, D.Sc., M.A., Jesus College. All the specimens possess excellent data, both of time and place, and many of them were bred. In addition to these butterflies there is also included a fine example of the interesting *Euschemon rafflesiae*, a very primitive Hesperid-like form, generally considered to be a moth. The whole series is a most interesting addition to the University collection, and brings out in a very striking way the essentially Papuan affinity of the northern tropical area of Australia. In addition to these, 2 beetles from Honolulu (1902) were also presented by Dr. Perkins.

A collection of 49 butterflies from the North Queensland Coast (1910) was presented by the captor, J. C. Kershaw, Esq. The specimens, which are all accompanied by exact data, were collected at Mossman (about 50 ft.), north of Cairns, and about twelve miles inland from Port Douglas.

An example of the interesting mimetic *Papilio laglazei*, from Dutch New Guinea (probably from the E. side of Geel-

vink Bay), was presented by the Hon. Walter Rothschild, F.R.S. The butterfly is an extremely interesting mimic of the Papuan Saturnian moth, *Alcidis aurora.*

Thirteen examples of *Papilio memnon agenor* from the Loo Choo Islands (1886 and 1891) were also presented by the same donor. The interest of the series consists in the single female form which is characteristic of these islands, and its comparison with the great variety of patterns exhibited by this sex in other parts of the geographical range of the species.

Specimens from the following localities were presented by Herbert Druce, Esq., F.L.S.:—

Various localities in Dutch and British New Guinea: a very valuable series of 60 butterflies, collected by A. E. Pratt (1902–3) and C. and F. Pratt (1908–9–10). The series includes examples of *Delias rothschildi*, *Delias bakeri*, and many other species greatly wanted by the Hope Collection, in which this most rich and interesting tropical island is unfortunately very poorly represented.

The Arru Islands:—2 *Euploeinae*, collected by A. E. Pratt (1905).

Koannania, Central Formosa:—2 moths, collected by Dr. A. Moltrecht.

Pyong-yang, Korea:—1 Argynnid butterfly (Moltrecht).

Sierra Leone and various other West African localities:—32 butterflies.

East Ecuador, collected by M. G. Palmer:—a fine set of 130 Lepidoptera taken at Baños on the Rio Pastaza (5,000–7,000 ft.); 43 taken at Alpayacu on the same river (3,600 ft.); 4 moths taken at El Rosario on the same river (4,900 ft.); 10 moths taken at El Topo on the same river (4,200 ft.); 9 moths taken at La Victoria on the same river (3,500 ft.); 4 moths taken at Canelos on the Rio Bobonaza (2,100 ft.); 3 moths taken on the Rio Pastaza (5,000 ft.).

Colombia, collected by M. G. Palmer :—25 butterflies taken during February, 1909, at different localities on the Rio Tamaua (300-400 ft.).

Peru, collected by M. Trujillo :—5 moths from El Porvenir (900 metres), October, 1909.

Mexico, collected by M. Trujillo :—12 moths from Jalapa.

New Zealand : 19 moths.

Fifteen South American Odonata (Dragonflies), chiefly collected on the canal banks, Georgetown, British Guiana, March 18–25, 1901, were presented by the captor, W. J. Kaye, Esq., F.E.S., together with a Tabanid fly from the same locality.

ADDITIONS TO THE BRITISH COLLECTIONS IN 1911.

Seven specimens of mimetic Hemiptera and their Hymenopterous models, as described in the Proc. Ent. Soc. London, 1911, pp. xxx–xxxiii, were presented by the captor, Mr. A. H. Hamm of the Hope Department. The specimens were :—

Alydus calcaratus from the New Forest together with the model *Salius exaltatus* collected in the same locality and on the same day, viz. August 14, 1908. Also examples of the earlier stages of the *Alydus*, in company with the ant *Formica fusca*, race *fusco-rufibarbis*, Beaulieu Road Station, August 10, and again on August 14, 1908. Furthermore two of these larval Hemiptera collected with *Formica rufa*, at Wellington College, April 2, 1904. The specimens illustrate in a striking manner the interesting fact that quite different groups of Hymenoptera are mimicked in the different stages of the species.

Nabis lativentris, captured in company with the ant *Lasius fuliginosus* at Wellington College, August 10, 1907, and also in company with *Lasius niger* at Bembridge, Isle of Wight, July 8, 1909.

A very valuable collection of British birds has been lent to the Hope Department by Mr. F. C. Woodforde, B.A., Exeter College.

The collection consists of 118 glass cases of mounted birds, collected for the most part in Somersetshire and on

Lundy Island by the late Mr. F. H. Woodforde, between the years 1837 and 1867. In the greater number of cases both male and female are represented. The chief interest of the collection lies in the birds being all British examples, and in the number of rare species included. Of these some, e.g. the golden oriole, chough, hoopoe, marsh-harrier, hen-harrier, kite, honey-buzzard, osprey, bittern, curlew-sandpiper, though formerly abundant and for the most part breeding in Britain, are now either very rare, occasional specimens only being taken, or, as in the case of the chough, very local. Others, e.g. the buff-breasted sandpiper and Bartram's sandpiper, are exceedingly rare visitors, very few specimens having ever been secured. The pair of marsh warblers, obtained about the year 1862, are said to be the first of this species to be recorded in Britain.

This collection has been placed in the Museum on loan for a period of ten years, at the end of which time, if not claimed by Mr. Woodforde's son, the whole will become the property of the University. In the latter event this collection will form a valuable accession to the very incomplete Museum series illustrating British ornithology, and will fill many of the gaps in the collection.

The Hope Library.

Mr. F. C. Woodforde has very kindly helped the Professor, as in 1910, in drawing up the following list of the important and numerous accessions presented in 1911.

Donations.

The following publications and Reports were presented :—

Bombay Natural History Society: the publications for 1911.

British Museum, Trustees of the :—

- Catalogue of the Lepidoptera Phalaenae in the British Museum, vol. x, with Supplementary volume of plates CXLVIII–CLXXIII, by Sir George F. Hampson.
- A Handbook of the Tsetse-flies (Glossina), by E. E. Austen.

Bryn Mawr College: Monographs. Reprint Series, vol. ix. Bryn Mawr, Penna, 1910.

Cambridge University: Forty-fifth Annual Report of the Museum and Lecture-Rooms Syndicate (for 1910).

Chambre de Commerce de Lyon. Essai de Classification des Lépidoptères Producteurs de Soie. 7^e Fasc. Bombycides. Lyon, 1911.

Colombo Museum, Ceylon: Administration Reports, 1910–11. Spolia Zeylanica, vol. vii, pts. xxv, xxvii and xxviii.

Federated Malay States Museum, Journal of, vol. iv, pts. 1, 2, 3, 4.

Indian Museum, Calcutta, Records of: vol. iv, pts. 6–9; vol. vi, pts. 1–5. Index to vol. v. Annual Reports, 1909–10, 1911–12. Memoirs, vol. ii, index; vol. iii, No. 2.

Instituto Oswaldo Cruz: Memorias, vol. iii, pt. 1. Rio de Janeiro, 1911. Title-page and contents of vol. ii.

London: Local Government Board Report (New Series, No. 53): Further Reports (No. 4) on Flies as Carriers of Infection. London, 1911.

Maine, University of: Agricultural Experiment Station, Orono. Five bulletins, and list of papers from the Station.

Manchester Museum: (1) Report for 1910; (2) Handbook: Outline Classification of the Animal Kingdom. Edited by Professor S. J. Hickson, F.R.S.

Marine Biological Association of the West of Scotland: Annual Report for 1910.

Northumberland Sea Fisheries Committee: Report. Edited by Professor A. Meek. 1908–9.

Ottawa: Experimental Farms of Canada: Reports, 1910; published 1911:

Bulletins 47 and 68 of the Central Experimental Farm.

Report, &c., of the Director to Select Committee on Agriculture and Emigration.

Pennsylvania, University of: Contributions from the Zoological Laboratory for 1910–11.

Radcliffe Library: Catalogue of the Books added to the Library in 1910.

Royal College of Surgeons: Annual Museum Report, 1911.

Smithsonian Institution, Washington: Memoirs by the following authors:—E. A. Andrews, A. Busck, O. F. Cook (3 memoirs), T. D. A. Cockerell (3), J. C. Crawford (4), A. A. Doolittle, W. D. Pierce, Harriet Richardson (3), S. A. Rohwer (4), H. L. Viereck (4), C. D. Walcot, C. B. Wilson (2).

Uganda Protectorate: Report of the Government Entomologist, C. C. Gowdey, B.Sc., &c., for 1909–10.

United States Department of Agriculture, Bureau of Entomology: Publications for 1911 and a few of 1909 and 1910, comprising 6 circulars, 12 bulletins, Technical Series, No. 16, pt. iv, and Monthly Lists of Publications. The publications include an important paper on the Importation into the United States of the parasites of the Gipsy Moth and the Brown-tail Moth, by L. O. Howard and W. F. Fiske.

United States National Museum, Annual Report: Washington, 1911.

The following authors have presented their publications to the Library:—

Professor Chr. Aurivillius: Seven memoirs, including Part I of the Lepidoptera von Madagaskar, den Comoren und den Inseln Ostafrikas, from Voeltzkow's *Reise in Ostafrika, &c.*, 1903–5, Stuttgart, 1909; and Part IX, viz. the Lepidoptera of the Swedish Zoological Expedition to Kilimandjaro, Meru, &c., Stockholm, 1910.

R. S. Bagnall, F.L.S., F.E.S.: A valuable series of thirty-five memoirs, chiefly devoted to the Thysanoptera, but also including papers on Isopoda, Coleoptera, &c., together with fourteen by the following authors: W. M. Axelson, Dr. P. Buffa (3 memoirs), B. F. Cummings, H. J. Franklin (2 memoirs), A. R. Jackson, B.M., M.Sc., A. Patience (2 memoirs), Dr. Harald Schott (2 memoirs), T. Southwell, F.Z.S., and T. F. Tullberg.

G. T. Bethune-Baker, F.L.S., F.E.S.: Seven memoirs, including Descriptions of New Species of Rhopalocera from Africa and New Guinea (P.Z.S., 1908, p. 110), and Revision of the African Species of the Lycaenesthes group of the Lycaenidae. (Trans. Ent. Soc., 1910.)

E. A. Birge and C. Juday: Inland Lakes of Wisconsin: Wisconsin Geological and Natural History Survey. Madison, 1911.

Lawrence Bruner, Nebraska: Two memoirs, including Acridoidea from Madagascar, &c. From Voeltzkow's *Reise in Ostafrika in den Jahren* 1903–5, Bd. II. Stuttgart, 1910.

Dr. Malcolm Burr, M.A., D.Sc., New College: Seven memoirs on Dermaptera, including the monograph on the group in Wytsman's "Genera Insectorum".

T. L. Casey: Memoirs on the Coleoptera, II. Lancaster, Pa., 1911.

W. E. Collinge and J. W. Shoebotham: The Apterygota of Hertfordshire, 1910.

J. A. Gilruth, Georgina Sweet, J. B. Cleland, and T. H. Johnston: Onchocerca gibsoni, &c. (Sydney, 1911).

H. Maxwell Lefroy, F.E.S.: List of Insects in the Pusa Collection: Coleoptera, Diptera, Lepidoptera, Orthoptera, Neuroptera, Hymenoptera, Rhynchota (Calcutta, 1910).

Charles Oberthür: Études de Lépidoptérologie comparée, Fasc. V, 2e Pt., with coloured plates LXXXVI to XCVI and many reproductions of photographs (Rennes, 1911).

J. A. G. Rehn: Five memoirs, including a treatise on the Orthoptera of Bermuda (Proc. Acad. Nat. Sci. Phila., 1910); and, in conjunction with Morgan Hebard, Preliminary Studies of N. Carolina Orthoptera and Records of Georgia and Florida Orthoptera (ibid., 1910).

Professor C. Sasaki (Imperial Univ. of Tokyo): Two memoirs on the feeding of silkworms (Bull. Coll. Agric. Imp. Univ. Tokyo, Vol. VI, 1904); On the Silk Fish-line (Tegusu) (Journ. Coll. Agric. Imp. Univ. Tokyo, Vol. II, No. 2, 1910); On the life-history of Trioza Camphorae (ibid., Vol. II, No. 5, 1910).

W. Schaus: Eight memoirs on Neotropical Lepidoptera.

Rowland E. Turner, F.E.S.: Twelve memoirs, including two on Tessmann's Expedition in S. Cameroon and Spanish Guinea (Mitt. Zool. Mus. Berl., V. 3, 1911); An Addition to our Knowledge of the Fossorial Wasps of Australia (P.Z.S., 1910, p. 253); Thynnidae from the Australian and Austro-Malayan Regions (Annales Musei Nationalis Hungarici, VIII, 1910); and Thynnidae and Scoliidae collected in Paraguay by Prof. Anisits, &c. (Spengel's Zool. Jahrb. XXIX, 2, 1910).

Rev. T. R. R. Stebbing, M.A., Worcester College, F.R.S.: Indian Isopods (Records of the Indian Museum, Vol. VI, Pt. IV, Calcutta, 1911).

Dr. C. Wesenberg-Lund: Six memoirs on the Biology of the Danish Fresh Waters.

Original papers have also been presented by the following authors:—J. Assmuth; Prof. T. Hudson Beare, B.Sc., &c.; H. J. Carter, B.A., F.E.S.; W. C. Crawley, B.A.; C. R. Crosby; H. St. J. K. Donisthorpe, F.Z.S. (in conjunction with W. C. Crawley); A. d'Orchymont; H. Druce, F.L.S., F.Z.S.; H. Eltringham, M.A., New College; Dr. A. Forel; Dr. A. Griffini; Dr. G. Horvath; W. D. Hunter (in conjunction with F. C. Bishop, Washington); E. G. Joseph, B.Sc., Lincoln College; J. C. W. Kershaw (2 memoirs, and 2 memoirs in conjunction with the late G. W. Kirkaldy); R. E. Kunzé, M.D. (3 memoirs); Capt. C. F. U. Meek, F.L.S.; J. C. Moulton, Magdalen College; F. Muir (in conjunction with J. C. W. Kershaw); E. Olivier; G. E. Sanders; J. G. Sanders (2 memoirs); R. Shelford, M.A.; Dr. A. E. Shipley, D.Sc., F.R.S., Master of Christ's College, Cambridge (2 memoirs).

Valuable additions to the Library have been presented by the following donors:—

Mrs. Edward Saunders: A very valuable series of nearly 90 papers, almost exclusively dealing with the Hymenoptera. The papers had formed part of the library of Edward Saunders, F.R.S., and many of them gain additional value and interest from the manuscript notes written by the late distinguished naturalist. The series, which contains many

papers that are now difficult to procure, includes the following :—

Die Blattwespen nach ihren Gattungen und Arten. XVI, by Dr. F. Klug, 1817.

Dispositio Methodica Specierum Scandinavicarum ad Familias Hymenopterorum Naturales pertinentium ab A. G. Dahlbom, Dr.Ph. Pt. I, Lund, 1842.

Two copies of a memoir by H. de Saussure on New Wasps of Mexico and N. America, 1857.

A list of Hymenoptera collected in Sicily in 1859 by Dr. Sichel (Ann. Soc. Ent. Fr., 1859, p. 749).

Memoir on the European Species of the genus Eudorea (Crambides) by Dr. de la Harpe (Mitth. d. Schweiz. Ent. Ges., Nr. 4, Apr., 1863).

Papers by J. G. Desborough and Frederick Smith from Pt. II of Trans. Ent. Soc. for 1868.

Miss Pascoe : The following valuable publications, augmenting or completing the donations in 1909 of Zoological works from the library of her father, the late Mr. F. P. Pascoe, F.L.S., F.E.S. :—

Proceedings, Linnean Society, May, 1890, and August, 1891.

Stainton's Manual, Vols. I and II, 1857 and 1859.

Bericht über die wissenschaftlichen Leistungen im Gebiete der Entomologie, 1891 (Crustacea, 1889), Bertkau u. Hilgendorf, Berlin, 1892.

A Monograph of British Copepoda, III, Brady; Ray Society, 1880.

A bound volume of papers (from 1867) on American Coleoptera, by Dr. G. H. Horn, M.D.

Hymenoptera Aculeata of the British Islands, E. Saunders, Pts. VIII and IX, London, 1895.

Lepidoptera of the British Islands, G. C. Barrett, 12 parts, London, 1892–1902.

Dr. G. B. Longstaff, D.M., New College: Palaeontographical Society, vol. for 1910: Monograph of the terrestrial

Carboniferous Arachnida of Great Britain by R. I. Pocock, F.L.S.; Trans. Zool. Soc. Lond., Vol. XVIII, pt. 4, Crustacea of the Order Cumacea in Copenhagen Museum, Pt. II, by W. T. Calman, D.Sc., &c.; Memoirs of N. S. Wales Naturalists' Club, No. 1, Sydney, 1903, Catalogue of Australian Rhopalocera, by G. A. Waterhouse.

G. A. James Rothney, F.E.S.: Six Memoirs on Hymenoptera, including two by Dr. A. Forel, together with the Trans. Ent. Soc. Lond. for 1909–10, bound uniformly with the earlier volumes given by the same generous donor.

Hon. Walter Rothschild, F.R.S.: The parts of the Novitates Zoologicae of the Tring Zoological Museum, published in the year 1911.

R. Shelford, M.A., Emmanuel College, Cambridge: Eleven publications of the U. S. Department of Agriculture, Bureau of Entomology, 1910 and 1911, including Contributions towards a Monograph of the Bark-weevils of the genus Pissodes, by A. D. Hopkins, Ph.D., Washington, 1911.

Schizopodous Crustacea from the North-east Atlantic Slope, Second Supplement, by W. M. Tattersall, M.Sc. From the Dept. Agric. and Techn. Instr. for Ireland, Dublin, 1911.

Memoir on Hispidae of Borneo by Dr. R. Gestro, Bull. Soc. Ent. Ital., xli, 1909, p. 122.

Memoir on the Paussidae of Eritrea, by Dr. R. Gestro, Bull. Soc. Ent. Ital. xli, 1909, p. 255.

Contributions to the Lepidopterous Fauna of the Philippines, by W. Schulze, Bureau of Science, Manila, 1910.

On a new instance of Ant Mimicry, by R. I. Pocock, F.L.S., F.Z.S., P.Z.S., 1910, p. 837.

The Professor:

The publications of the Société Entomologique de France for 1911; and of the Société Entomologique de Belgique for 1911; the publications of the Linnean Society for 1911; the Transactions of the Entomological Society of London for 1911; the Journal of Economic Biology, Vol. VI (1910); Boletín X, 1910, XI, 1911, and Vol. V, Memorias 5 and 6 de la Real Sociedad Española de Historia Natural; Bulletin of Ento-

mological Research, Vol. i, pt. iv, Vol. ii, pts. i, ii, iii; Lancashire and Cheshire Entomological Society, Annual Report for 1910; Bref och Skrifvelser af och till Carl von Linné, Stockholm, 1911.

Exchanges.

The parts of the following journals for the year 1911 were received in exchange for the Hope Reports:—

Deutsche Entomologische National-Bibliothek.
Deutsche Entomologische Zeitschrift.
Entomologisk Tidskrift, Stockholm.
Bulletin de la Société Entomologique Suisse.

Purchases.

The following publications of the year 1911 were purchased for the Department:—The volume of the Ray Society, of the Zoological Record, the numbers of the Entomologist's Monthly Magazine, the Entomologist, and the Entomologist's Record.

In addition to these regular purchases there was also bought:—Ichneumonologia Britannica, IV, The Ichneumons of Great Britain: *Tryphoninae*, by Claude Morley, F.E.S., F.Z.S., London, 1911.

E. B. POULTON.

Report of the Hope Professor of Zoology, 1912.

The two great pieces of work which mark the year 1912 are the transference of the Lepidoptera into the Old Radcliffe Library together with the consequent reorganization of the whole Department, and the meeting of the Second International Entomological Congress in August. In the transference of the collections the permanent staff received very kind help from the Rev. C. F. Thornewill and Mr. F. C. Woodforde, and the removal of the immense mass of delicate specimens was accomplished without any injury.

By the death of Mr. R. Shelford, after years of illness, the Department lost one of its chief friends and one who had worked hard in securing its efficiency. The present condition of the collections of Orthoptera, and especially the *Blattidae*, will remain as a monument to his indefatigable labours.

Mr. R. S. Bagnall, who has been appointed Assistant Curator in succession to Mr. Shelford, has unfortunately been prevented from beginning his permanent work, although able, from time to time, to render valuable assistance. It is confidently hoped that he will be able to come into residence in a few weeks.

1. *The Rothney Collection of Hymenoptera.*

Mr. G. A. James Rothney has continued his generous donations to the Library and to the splendid collection of Hymenoptera presented in 1910.

2. *Additions to the Collection of Lepidoptera from Equatorial Africa.*

It was explained in the Report for 1911 that four great collections from the African Equatorial Zone were almost entirely uncatalogued. In the course of the year one of these, the collection made and presented by the Rev. K. St. Aubyn Rogers, M.A., Wadham College, has been entirely

labelled, catalogued, and incorporated, and a full account of it will be found under the additions for the year 1912; for it was thought convenient that the Collection should be described and acknowledged as a whole under one year, although it had gradually accumulated in the course of eight. It must be added that important instalments, although only a small part of the whole, have been incorporated and acknowledged in some of these years, but form no part of the Collection described on pp. 954–958. A small but important section of Mr. W. A. Lamborn's Collection from the Lagos district of Southern Nigeria has also been catalogued, and will be found acknowledged under the years 1910–12, and a still smaller proportion of Mr. C. A. Wiggins's Collection from the Entebbe district under the years 1909–11. No specimens of Dr. G. D. H. Carpenter's Collection have as yet been catalogued, although those from the mainland to the north and north-west of the Victoria Nyanza are quite ready for numbering and incorporation, as is also the fine series from Damba Island in the Lake. It was, however, thought better to keep all these collections separate until Dr. Carpenter's return in the present summer, so that he could the more conveniently study them. Incorporation of these three collections is one of the principal pieces of work for the immediate future.

A fifth fine collection made by Mr. J. A. de Gaye, F.L.S., F.E.S., of King's College, Lagos, was also presented in the course of 1912, and this will be labelled and incorporated as soon as possible.

3. *Additions to British Collections.*

It will be seen in the list of accessions that an exceedingly important collection of *Empidae* and their prey, presented by Mr. A. H. Hamm, has now been incorporated. The arrangement follows Mr. Hamm's conclusions upon the capture of prey in relation to courtship, and many interesting and novel results will be found on p. 952, where the Collection is briefly described. Mr. F. C. Woodforde, Col. Yerbury,

Mr. H. Donisthorpe, and Dr. Longstaff have also continued their generous assistance to this important section of the Hope Department.

Mr. A. Bacot, F.E.S., who, with Mr. L. B. Prout, F.E.S., presented in 1910 the material of their great series of breeding experiments on *Acidalia virgularia*, has now generously given the material on which his many important papers were founded. A complete account will appear in a future Report, but in the meantime the specimens are at the disposal of all who desire to study insects or the data of heredity.

4. *Work done by the Staff.*

Early in the year the Department lost the services of Mr. W. Holland, who had been an assistant for nearly 20 years. His great services during this period and his generosity to the Collections are described in earlier annual Reports, and now again gratefully acknowledged.

The work done by Mr. A. H. Hamm and Mr. Joseph Collins is really sufficiently indicated by studying the list of accessions in the later pages of this Report. Furthermore, a great deal of extra labour was thrown upon them by the necessity for the reorganization of the entire Department in consequence of the removal into the Old Radcliffe Library, and by the Entomological Congress.

The loan collection of British Birds deposited by Mr. F. C. Woodforde has been cleaned, arranged, and provided with labels. A list of several of the rarest species, presented by Mr. Woodforde, will be found on p. 961.

5. *Work on the Collection of Pierinae.*

Dr. F. A. Dixey, F.R.S., has kindly drawn up the following report :—

"During 1912 several large collections of Pierines were worked out, and no less than 950 specimens incorporated in the Collection. About 500 of these were collected and presented by the Rev. K. St. A. Rogers in British East

Africa; they include *Teracolus sipylus*, Swinh. (the large form of *T. casta*, Gerst.), a fine series of *Mylothris rubricosta*, Mab., two specimens of which were abnormal in venation, two females of a species of *Teracolus*, at present unnamed, allied to *T. lais*, Butl., an exceptionally 'dry' specimen of *T. achine* reared on desiccated food, and other interesting forms. The two fine collections of Pierines made by Dr. Longstaff in the region of the White Nile were worked out and 255 specimens were incorporated during 1912. These included a good series of the rare *Calopieris eulimene*, whose affinities are still doubtful, and of the almost equally rare *Teracolus ephyia*, Klug. The former of these is new to the Collection, and the latter was only represented by one imperfect specimen. Other specimens incorporated were from collections presented by Mr. E. A. Elliott from Lanzarote, Canary Islands, Mr. J. C. F. Fryer in Aldabra, Dr. R. C. L. Perkins in N. Queensland, Mr. G. F. Leigh in the Comoro Islands, and Rev. J. U. Yonge in Madagascar. Among these the following were new to the Collection:—*Teracolus aldabrensis*, *Delias nigidius*, *Mylothris ngaziya*, *Terias desjardinsii*."

At the International Congress of Entomology, Dr. F. A. Dixey read a paper on the Scent-distributing Organs of the *Pierinae*, and arranged an exhibition which included about two-thirds of the Hope Collection of that Sub-family. Papers on the Pierine genus *Pinacopteryx*, and on the species of *Teracolus* allied to *T. ephyia* were contributed by him to the Proceedings of the Entomological Society of London (see p. 15).

6. *Work on the Collection of Acraeinae, &c.*

Mr. H. Eltringham, M.A., F.Z.S., F.E.S., New College, completed and saw through the press the MS. of his two years' labours on the *Acraeinae*. This monograph, occupying the whole of Part I (pp. 1–374) of the Trans. Ent. Soc. for 1911, was issued just in time for the Entomological Congress which met in August. The monograph contains sixteen plates, of which six are coloured, and is provided with an index separate from that of the Transactions for the year.

It is the standard work from which all the Museums of the world and all the private collections must determine and arrange the species of this important group of butterflies. In the course of its preparation the author has seen every accessible type and has dissected the male armature of every available species, and there were very few which he was unable to obtain for this purpose. Special mention must also be made of a most useful alphabetical list of types with a statement of their location so far as it is known. As soon as the monograph was published Mr. Eltringham arranged the University collection of *Acraeinae*, and about 80 of the drawers were on exhibition in one of the rooms of the Linacre Professor throughout the week of the Congress.

In collaboration with Dr. Karl Jordan Mr. Eltringham completed the section *Acraeinae* for the "Lepidopterorum Catalogus"—a work that has since been published (Berlin, 1913). With the same author he has completed the section *Acraeinae* for Wytsman's "Genera Insectorum" (Brussels). Mr. Eltringham has also been engaged upon the following researches:—

(1) Preliminary investigations into the urticating properties of the imago stage of *Porthesia similis*, *P. chrysorrhoea*, *Anaphe infracta*, and other Lepidoptera. (Proc. Ent. Soc., 1912, p. lxxviii.) This investigation, upon which he is still engaged, was suggested by Mr. W. A. Lamborn's observations in the Lagos district.

(2) Preliminary investigation into the structure of the male genital armature in certain species of *Heliconius*.

(3) The histological structure of the scent patches and abdominal brushes in the male *Amauris niavius*, described and figured in a paper read before the Entomological Society, to be published in the course of the present year.

7. *Work on the British Collections of Coleoptera.*

During the past year Commander Walker has continued his kind help, and has made considerable progress in the remounting and rearrangement of the Clavicorn Coleo-

ptera in the Hope-Westwood Collection. The *Anisotomidae* have been completed, as well as the larger *Silphidae*, the *Erotylidae*, *Endomychidae*, *Byrrhidae*, *Histeridae*, *Phalacridae*, and *Coccinellidae*, the last-mentioned family containing many examples of named varieties bearing Haworthian labels—of special interest as preserving the names by which these forms were known to the older Coleopterists. The great majority of the insects dealt with have made excellent specimens, and their examination is much facilitated by cleaning, repinning with suitable pins, and carding. Included in the above statement are the numerous specimens of these families contributed in past years to the Museum by Mr. H. St. J. Donisthorpe.

8. *Work on the British Collections of Lepidoptera.*

The butterflies and a part of the moths have been thoroughly rearranged by Mr. F. C. Woodforde, who has brought together the scattered collections of British Lepidoptera in the Department. This great service to the University involved residence in Oxford during last autumn and winter. As the result of this kind help, the specimens are now more instructive as well as far more available for the use of the student.

9. *Assistance in working out the material of the Department.*

Mr. W. A. Lamborn lived in the neighbourhood of Oxford for a large part of the year and gave much kind help in the arrangement of his collections, and later wrote two important papers which will be published in the immediate future. His work has just been recognized by his appointment as Entomologist to the Agricultural Department of Southern Nigeria and he has lately returned to the West Coast in order to undertake the duties of the office. The working out of his material, which ranges over many groups of insects, has required the co-operation of a number of naturalists. The Ants have been determined by Professor August Forel. Mr. W. C. Crawley kindly took the whole collection by hand to Switzerland, and brought it back when the work was done. Some of the Homoptera have been determined and many

new species described by Mr. W. L. Distant; other Homoptera, including the *Coccidae*, by Professor R. Newstead, F.R.S. The new *Lycaenidae* have been worked out by Mr. G. T. Bethune-Baker; Micro-Lepidoptera by Mr. J. Hartley Durrant. The whole of these researches will form an appendix to the paper embodying Mr. Lamborn's important observations on the Ants of the Lagos district in their relation to *Lycaenidae* and other insects.

The Rev. K. St. Aubyn Rogers spent a fortnight in Oxford arranging the African *Lycaenidae* and incorporating his own exceedingly important contribution to this group. The kindest assistance has been rendered, as in previous years, by the staff of the Insect Department of the British Museum of Natural History, as also by the Hon. W. Rothschild, F.R.S., and Dr. Karl Jordan of the Tring Museum, by Mr. Hamilton Druce, by Mr. G. T. Bethune-Baker, by Mr. Roland Trimen, F.R.S., and Mr. L. B. Prout.

An important manuscript on the African *Braconidae*, representing an immense amount of careful labour, has been left by the late G. H. Grosvenor. Dr. R. C. L. Perkins paid a special visit in order to examine this work as well as the material on which it is based, and it is hoped that the whole will be published in accordance with his kind suggestions and advice.

10. *Visits of Naturalists: the Second International Entomological Congress.*

Apart from the meeting of the Congress in August, the Hope Department has been visited by the following naturalists, who have generously helped with material or with assistance in working out the collections:—Mr. G. T. Bethune-Baker, F.L.S., Pres. Ent. Soc.; Mr. Horace Donisthorpe, F.E.S.; Mr. E. A. Elliott, F.Z.S., F.E.S.; Mr. C. A. Foster, F.E.S.; Dr. K. Jordan, Ph.D., F.E.S.; Mr. W. A. Lamborn, M.R.C.S., L.R.C.P., F.E.S.; Dr. G. B. Longstaff, M.A., D.M., F.R.C.P., F.E.S., New College; Professor R. Meldola, Hon. D.Sc., F.R.S., F.E.S.; Mr. Guy A. K. Marshall, F.E.S., Scientific Secretary to the Research Committee of the Colonial Office;

Mr. J. C. Moulton, B.Sc., Magdalen College, Curator of the Sarawak Museum, Kuching, Borneo; Mr. S. A. Neave, M.A., B.Sc., Magdalen College; Hon. Walter Rothschild, F.R.S., F.L.S., F.E.S.; Dr. H. Schouteden, Director of the Museum of the Congo, Tervueren, near Brussels; Rev. J. U. Yonge, M.A., Keble College.

The Department was also visited by Professor W. Bateson, F.R.S.; Professor Vernon L. Kellog, of the Leland Stanford University, California; Dr. F. A. Lucas, Director of the American Museum of Natural History, New York; Sir Henry Miers, F.R.S.; and Dr. Henry Skinner, of Philadelphia.

It is unnecessary to give an account of the Entomological Congress on the present occasion, for a full Report is in course of preparation. It is right to say that the meeting in Oxford of so many eminent representatives of the science from all parts of the world was, and has since been, a great source of strength to the Hope Department. It is also impossible to leave the subject without thanking Mr. Eltringham for his work, first as Local Secretary, and then—through the illness of the wife of Dr. Malcolm Burr, the elected officer—as General Secretary. His self-sacrificing labours were shared by his friend, the late G. H. Grosvenor, who rendered at the Congress his last service to Oxford. Dr. Dixey and Commander Walker, in Oxford, and Dr. Karl Jordan, Dr. Longstaff, and Professor Selwyn Image, paying many visits, all helped in the kindest manner to carry out the necessary arrangements for the meeting. A great deal of work also fell upon the assistants in the Hope Department, Mr. Hamm and Mr. Collins, who worked hard to place the Collections at the disposal of the members.

The success of the meeting was also due to the kind permission given by the Delegates of the Museum, to colleagues the Heads of the Museum Departments, to Colleges—especially Wadham, New College, and Merton—where members were given rooms and otherwise entertained, to Oxford residents who offered hospitality, and, above all, to the Warden of Wadham, who generously lent his private garden to the Congress, and permitted a tent to be erected in it.

The meeting of Entomologists, which usually takes place in July, was considered in 1912 to be merged in the Congress. A nearly complete record of those who attended is preserved in the Visitors' Book of the Hope Department—going back to the date, June 12, 1850, when many members of the University visited the collections, which had just arrived, and were accommodated in the Taylorian Building. From that date up to August, 1912, the book presents a very interesting record of the students of insects who have visited the Hope collections in Oxford. At the opening of the Congress on August 5 there were only some half-dozen blank pages left in the book, and these are now filled with 175 signatures of those who attended the meeting, August 5–10.

11. *Works published in* 1912.

The following papers appeared in the Transactions of the Entomological Society of London for 1912:—

Pt. I, No. I.—A Monograph of the African species of the Genus *Acraea*, Fab., with a supplement on those of the Oriental Region, by Harry Eltringham, M.A., F.Z.S., F.E.S., New College.

Pt. II, No. II.—South African and Australian Aculeate Hymenoptera in the Oxford Museum, by the late Col. C. T. Bingham, F.Z.S.

Pt. II, No. IX.—The Study of Mimicry (Batesian and Müllerian) by Temperature Experiments on two Tropical Butterflies, by Lieut.-Colonel N. Manders, R.A.M.C., F.Z.S., F.E.S.

Pt. IV, No. XII.—Studies of the *Blattidae*, by the late R. Shelford, M.A.

Pt. IV, No. XIV.—The Colour-groups of the Hawaiian Wasps, &c., by R. C. L. Perkins, D.Sc., M.A., Jesus College.

Pt. IV, No. XV.—Synaposematic resemblance between Acraeine larvae, by G. D. H. Carpenter, B.A., B.M. (Oxon.), F.E.S., Member of the Royal Society's Sleeping Sickness Commission.

Pt. IV, No. XVI.—The Life History of *Pseudacraea eurytus hobleyi*, Neave, by G. D. H. Carpenter, B.A., B.M. (Oxon.), F.E.S.

The following short papers, notes, and brief descriptions of the material of the Department, exhibited at the meetings of the Entomological Society of London in 1912, have been published in the Proceedings:—

Feb. 7, 1912, p. iii. Geometrid moths of the genus *Aletis* and their mimics, collected in the neighbourhood of Entebbe, by C. A. Wiggins, D.P.M.O. of the Uganda Protectorate.

Feb. 7, p. iv. *Hypolimnas* (*Euralia*) *dubius*, Beauv., proved to be a Mendelian dominant, and *H.* (*E.*) *anthedon*, Boisd., recessive, by W. A. Lamborn, M.R.C.S., L.R.C.P., Entomologist to the Agricultural Department of S. Nigeria.

Feb. 7, p. iv. Butterflies a natural food of Monkeys, by W. A. Lamborn.

Feb. 7, p. iv. The Urticating Hairs of a Lasiocampid larva disseminated through the air, by W. A. Lamborn.

Feb. 7, p. v. The Anal Tufts of the female Pierine butterfly *Glutophrissa saba* protruded during courtship, by W. A. Lamborn.

Feb. 7, p. vii. Discussion of Col. Manders's paper, "The Study of Mimicry (Batesian and Müllerian) by Temperature Experiments on two Tropical Butterflies," by Rev. G. Wheeler, F. E. Merrifield, Dr. T. A. Chapman, and the Professor.

March 6, p. xii. Three families of *P. dardanus*, Brown, bred from *hippocoon*, F., females, in the Lagos district, by W. A. Lamborn.

March 6, p. xvii. Monkeys eating Butterflies, by Capt. H. V. Neal.

March 6, p. xviii. Determination of the Coccid food of the larva of *Spalgis lemolea*, H. H. Druce, by Prof. R. Newstead, F.R.S.

March 6, p. xviii. *Eurytela dryope*, Cramer, shown to be distinct from *E. hiarbas*, Drury, by W. A. Lamborn.

March 6, p. xix. Further captures of Pseudacraeas, &c., on Damba Island, near Entebbe, by Dr. G. D. H. Carpenter.

March 20, p. xxv. A Coleopteron new to Britain, by Commander J. J. Walker, Hon. M.A., F.L.S., Sec. E. S.

March 20, p. xxvi. Lepidoptera with the "*Neptis*" pattern, collected near Entebbe in 1909, by C. A. Wiggins.

March 20, p. xxviii. *Neptis swynnertoni*, a new species from S.E. Rhodesia, by Roland Trimen, Hon. M.A., F.R.S.

March 20, p. xxxi. Two African species of the Danaine genus *Tirumala* (*Melinda*) as models, and one as a mimic, by the Professor.

March 20, p. xxxii. A large Lepidopterous pupa, probably Lycaenid, found in the leaf-nest of *Oecophylla*, in the Lagos district, by W. A. Lamborn.

March 20, p. xxxiii. The sluggishness of two W. African *Lycaenidae* of the genera *Epitola* and *Hewitsonia*, by W. A. Lamborn.

March 20, p. xxxiv. The male *Amauris egialea* stroking the brands of the hind wings with its anal tufts, by W. A. Lamborn.

March 20, p. xxxv. Discussion of the above observation by Dr. F. A. Dixey, M.A., D.M., F.R.S., Wadham College, and Prof. Kellog.

May 1, p. xlii. A very scarce Egyptian Pierid, by G. B. Longstaff, M.A., D.M., F.R.C.P., New College.

May 1, p. xlii. Birds and Insects at the edge of fire, by Dr. G. B. Longstaff.

May 1, p. l. Mimicry in the Tropics chiefly characteristic of Forest Areas: The Birds and Lizards of the Forest and the Open, by His Excellency the Governor of Uganda, C. A. Wiggins, C. F. M. Swynnerton, F.E.S., and the Professor.

May 1, p. liii. The Power of Sight in Birds, by Dr. Monckton Copeman, F.R.S., and the Professor.

May 1, p. lv. A Wagtail devouring Lycaenid and Pierine

Butterflies but rejecting an *Acraea*, near Entebbe, by S. A. Neave, M.A., B.Sc., Magdalen College.

May 1, p. lv. *Neptis* and *Neptidopsis* in the Lagos district, by W. A. Lamborn.

May 1, p. lvi. *Eurytela hiarbas* and *E. dryope*, by Roland Trimen.

May 1, p. lvi. Abstract and discussion of Dr. R. C. L. Perkins's paper "On the Colour-Groups of the Hawaiian Wasps", by the Professor.

June 5, p. lxviii. Two Uncommon Sudanese Pierine Butterflies, by Dr. G. B. Longstaff.

June 5, p. lxx. Mimetic East African Asilid flies and Butterflies (*Pseudacraea*), by S. A. Neave.

June 5, p. lxxiii. Heredity in the female forms of *Hypolimnas misippus*, L., by Rev. K. St. Aubyn Rogers, M.A., F.E.S., Wadham College.

June 5, p. lxxv. The Tsetse-fly *Glossina caliginea*, Austen, rejected by a Monkey, by W. A. Lamborn.

June 5, p. lxxv. Families of Nymphaline and Danaine Butterflies bred in the Lagos district, by W. A. Lamborn.

June 5, p. lxxviii. The Breeding of *Eurytela hiarbas*, Drury: a correction, by W. A. Lamborn.

June 5, p. lxxviii. The urticating hairs of the moths *Anaphe infracta*, Walsingham, *Porthesia similis*, and *P. chrysorrhoea*, by W. A. Lamborn and H. Eltringham.

June 5, p. lxxxi. The cocoons of the African Lasiocampid moth *Chrysopsyche varia*, Walk., by Dr. G. D. H. Carpenter.

June 5, p. lxxxii. The warning colours of the Hypsid moth "*Callioratis*" *pactolicus*, Butl., in all its stages, by Dr. G. D. H. Carpenter.

June 5, p. lxxxiii. Diurnal movements of Acraeine pupae, by Dr. G. D. H. Carpenter.

June 5, p. lxxxiv. Pseudacraeas of the *hobleyi* group on the Sesse Islands in the Victoria Nyanza, by Dr. G. D. H. Carpenter.

Oct. 2, p. lxxxvii. Coleoptera from Oxford and insect-catching grass, by Commander J. J. Walker.

Oct. 2, p. lxxxviii. The flower-like arrangement of African Flatas (Homoptera), by C. J. Gahan, Dr. A. C. Parsons, W. A. Lamborn, and the Professor.

Oct. 2, p. xc. *Euchelia jacobaeae*, L., captured and then abandoned by a Robin, by Roland Trimen.

Oct. 16, p. xcvii. Occasional migration due to excessive drought as a cause of the spread of Butterflies into new localities, by Rev. K. St. Aubyn Rogers, M.A., F.E.S., Wadham College.

Oct. 16, p. xcix. The special development of Mimicry in forest Butterflies, by C. F. M. Swynnerton.

Oct. 16, p. c. *Eurytela hiarbas*, Drury, and *E. dryope*, Cramer, by G. F. Leigh.

Oct. 16, p. c. Müllerian mimicry between Australian Bees, by Dr. R. C. L. Perkins.

Oct. 16, p. ci. Cocoons of *Norasuma kolga*, H. Druce, spun under natural conditions, by W. A. Lamborn.

Oct. 16, p. ciii. Synaposematic resemblance between Acraeine larvae, by Dr. G. D. H. Carpenter. Additional note in reading the above paper by the Professor.

Nov. 6, p. cvi. A myrmecophilous African Lycaenid, by W. A. Lamborn.

Nov. 6, p. cvi. The value of photographs, even when greatly reduced, as a record of habits, attitudes, &c., by Dr. C. William Beebe.

Nov. 6, p. cvi. The production of the spherical structures on the Cocoons of the Tineid moth *Epicephala chalybacma*, Meyr., by E. E. Green, F.E.S.

Nov. 6, p. cix. The West African Agaristid moth *Messaga monteironis*, Butler, a mimic of the Hesperid *Pyrrhochalcia iphis*, Drury, by J. A. de Gaye, F.L.S., F.E.S.

Nov. 6, p. cx. The Pierine genus *Pinacopteryx*, by Dr. F. A. Dixey, M.A., D.M., F.R.S., Wadham College.

Nov. 6, p. cxiv. Protective resemblance of an African Acridian to grass-stems charred by native fires, by A. Bacot, F.E.S.

Nov. 6, p. cxiv. Gigantic W. African Lasiocampid larvae, by H. Eltringham.

Nov. 6, p. cxiv. The Life-History of *Pseudacraea eurytus hobleyi*, Neave, abstract and further notes, by Dr. G. D. H. Carpenter.

Nov. 20, p. cxix. Families of Nymphaline and Pierine butterflies bred in the Lagos district, by W. A. Lamborn.

Nov. 20, p. cxxi. Example of the complex struggle for life among insects in the W. African tropics, by W. A. Lamborn.

Nov. 20, p. cxxiii. The Butterflies of the White Nile, a study in Geographical Distribution, by Dr. G. B. Longstaff: discussion of above paper.

Dec. 4, p. cxxx. Metallic colour in Chrysids, by Dr. G. B. Longstaff: discussion.

Dec. 4, p. cxxxi. The forms of *Leuceronia argia*, F., in the Lagos district of West Africa, by W. A. Lamborn.

Dec. 4, p. cxxxi. Three families of *Papilio dardanus*, Brown, bred from known female parents in the Lagos district of West Africa (1912), by W. A. Lamborn.

Dec. 4, p. cxxxiv. Families of *Papilio dardanus*, Brown, bred in Natal from female parents of the *trophonius*, Westw., form, by Miss M. E. Fountaine and G. F. Leigh.

Dec. 4, p. cxxxvi. Further families of Pseudacraeas of the *hobleyi* group bred on Bugalla in the Sesse Archipelago, by Dr. G. D. H. Carpenter.

Dec. 4, p. cxxxviii. The Cocoons of *Epicephala chalybacma*, Meyr., by T. Bainbrigge Fletcher, F.E.S.

Dec. 4, p. cxxxviii. A richly coloured example of *Planema arenaria*, E. M. Sharpe, from the Sesse Islands in the Victoria Nyanza, by Dr. G. D. H. Carpenter.

Dec. 4, p. cxxxviii. The effect of hot and cold climate

upon the colours of *Chrysophanus phlaeas*, L., by Dr. R. C. L. Perkins.

Dec. 4, p. cxli. Some African species of the genus *Teracolus*, by Dr. F. A. Dixey.

In the *Entomologist's Monthly Magazine* for 1912:—

pp. 79–84. Unintentional evidence of Mimicry in Bornean Butterflies, by J. C. Moulton, B.Sc., Magdalen College, Curator of the Sarawak Museum, Kuching, Borneo.

"Butterfly Hunting in Many Lands," by Dr. G. B. Longstaff, containing an account of the author's journeys and experiences in the field, and representing a large amount of work during many years in the Hope Department. The work contains, as an appendix, translations by Mr. E. A. Elliott, F.Z.S., of papers by Fritz Müller on the scent-organs of butterflies and moths originally issued in various publications, some of them very inaccessible.

12. *Forthcoming Volumes of Hope Reports.*

The great pressure due to the transference and rearrangement of the collection in 1912, and to the Entomological Congress, prevented the appearance of the eighth Volume. There is now the material for two Volumes of Reports of the large octavo size of Vols. I–VII, and also one or perhaps two Volumes containing papers of a larger size. It is hoped that all the material now collected in the Department will be issued in the course of the present summer.

Additions to the Collections in 1905.

A beautiful series of 84 Lycaenid butterflies from the Nicobar Islands (April–June, 1904) was presented by the captor, Gilbert Rogers, Esq. The remainder of this generous donation was acknowledged in the Report for 1906, but the *Lycaenidae* having been kindly named by Mr. H. H. Druce, F.L.S., had been put aside in order that the determinations might be affixed to the specimens. This has now been done, and all are incorporated in the collection.

Thirteen butterflies and 25 moths, including some interesting species of *Agaristidae*, were presented by C. A. Wiggins, Esq., D.P.M.O. of the Uganda Protectorate. The specimens were taken by a native collector at Taveta (2,500 ft.), B. E. Africa, in May, 1905.

Additions to the Collections in 1909.

A fine collection of insects of various Orders from localities in the neighbourhood of Cairo and Khartum and in many parts of Upper Egypt was presented by the captor, Dr. G. B. Longstaff, D.M., F.R.C.P., New College. The data are detailed and precise, including a record of the latitude of the small places on the White Nile above Khartum. The specimens were captured between the beginning of January and mid-April, 1909. The following groups are represented:—

Lepidoptera Rhopalocera.—194, including a fine series of the forms of *Danaida chrysippus* (the single example of *dorippus* was of the white hind-winged *albinus* form), and 8 *Calopieris eulimene*, a very interesting Pierine excessively rare in collections.

Lepidoptera Heterocera.—177, including some very rare species.

Hymenoptera.—96 ants and *Mutillidae*, 185 Fossores, 71 Diploptera, 203 Anthophila, 47 *Chrysididae* (the above Hymenopterous groups being very kindly worked out by Rev. F. D. Morice, M.A., F.E.S., Queen's College), 5 Parasitica.

Diptera.—57.

Neuroptera.—23, including 16 Odonata.

Coleoptera.—The specimens numbered many over 130, because two or more examples of all the smaller species were mounted on a single card.

Hemiptera.—52.

Orthoptera.—69, including 9 *Forficulidae*. The collection also included 3 Arthropoda outside the Insecta.

Seven Coleoptera from the southern slope of Vesuvius

(April 23) and a Reduviid bug from the deck of the steamer at Gibraltar (April 27), captured by Dr. Longstaff on his journey home, were also presented by him to the Hope Collection.

A fine series of Tabanid flies from Northern Rhodesia and the South-east of the Congo State was presented by the captor, S. A. Neave, Esq., M.A., B.Sc., Magdalen College: 91 have been catalogued, and together with large numbers of additional specimens incorporated in the Collection. The interest and value of the donation has been greatly increased by the fact that all the species have been determined by Mr. E. E. Austen of the British Museum. A brief account of the localities visited by Mr. Neave in 1909 has been published in the Reports of earlier years.

Sixty-eight *Acraeinae* from N.E. Rhodesia and the S.E. of the Congo State were also presented by S. A. Neave, Esq. This series, which is an addition to the splendid collections acknowledged in earlier Reports, contains the following interesting types or paratypes of the genus *Acraea*:—*A. mansya*, Eltringham; *chambezi*, Neave; *mima*, Neave; *lualabae*, Neave; *diogenes*, Suff. (*lactea*, Neave); and *sotikensis katana*, Eltringham. Four examples of *Planema poggei* are also included in the series.

Two *Lycaenidae*, including 1 *Deloneura ochrascens*, from Pemba village (about 300 ft.), Duruma country, about 25 miles W. of Mombasa and 10 S.W. of Rabai, were presented by the captor, O. F. Watkins, Esq.

Thirty-eight butterflies collected in June–July, 1909, in the Ambinanindrano district, Madagascar (400–500 ft.), were presented by the captor, Rev. J. U. Yonge, M.A., Keble College. The series includes *Acraea igati*, *Hypolimnas drucei*, *Neptis kikideli*, &c.

Five African Diptera, presented by the Entomological Research Committee of the Colonial Office, have been added to the Collection.

Forty-one butterflies and one moth, collected in 1909 by C. M. Dammers, Esq., in the mountain forests (3,000–

6,000 ft.) near Concepcion, in the Tucuman Province of N.W. Argentine, were presented by J. Blamey, Esq. The locality renders this little collection of especial value to the Department, for the tropical species of *Ithomiinae*, *Heliconinae*, &c., were taken near the southernmost limit of their range. The mountain *Satyrinae* include fine species new to the University collection.

Six *Nycteribiidae* were presented by the captor, Hugh Scott, Esq., M.A., Trinity College, Cambridge.

Additions to the Collections in 1910.

The following part of the splendid series collected in the neighbourhood of Oni Camp, 70 miles E. of Lagos, and presented by W. A. Lamborn, Esq., have been catalogued and added to the collection:—64 *Papilioninae*, including 4 *P. zalmoxis*, 4 *cynorta*, 1 *hesperus*, 5 *leonidas*, and 10 ♂ *dardanus*, and, for the bionomic series, 3 specimens injured probably by the attacks of enemies, namely, 1 *dardanus* ♀ f. *hippocoon*, 1 *hesperus*, and 1 *nireus nireus*. Bred specimens, together with the pupa-cases from which they emerged, are present in the series of the following species:—*nireus nireus*, *demodocus*, *menestheus*, *policenes*, and *dardanus*. The *Acraeinae* added to the collection include 100 *A. pentapolis*, of which a single specimen was bred from a wild pupa, and the remainder formed a part of the butterflies bred from 3 companies of larvae, together with the whole of those bred from a fourth company. Many pupal cases and larval skins have been labelled and added to the collection. This species is dimorphic—some of the butterflies being yellow- and some red-marked. The proportion between these two forms is well shown, especially in the entire Company 4, of which 35 specimens were red- and 30 yellow-marked. *A. rogersi lamborni*: 107 specimens, including in this number many pupae and larval skins. Among the examples are the whole of the 21 specimens reared from a single company of larvae and a part of a second company. The whole series of this species consists, with a single exception, of bred specimens. It includes the ♂ and ♀ types of the subspecies *lamborni*,

Eltringham. *A. quirina*: 11 specimens captured and 1 bred, 52 specimens, including several pupae and some larval skins, bred from a number of larvae which had scattered, but almost certainly belonged to a single company. A single specimen of this species found on the upper side of a leaf with both hind wings shorn off has been added to the bionomic series. *A. admatha*: the 22 catalogued specimens include many bred imagines, together with their pupa-cases and larval skins, and the same is the case with many of the 44 examples of *A. zetes*. The Acraeas also included single examples of *neobule seis* and *camaena*, and 2 of *egina*.

A portion of the extremely fine collection from the neighbourhood of and within the forest on Mt. Chirinda (about 3,800 ft.), Melsetter, Gazaland, S.E. Rhodesia, collected over two or three years previous to 1910 by C. F. M. Swynnerton, Esq., and presented by him, has now been catalogued and the specimens incorporated. Of *Papilio dardanus* there have been incorporated in the general collection 22 ♂s and 20 *hippocoon* ♀s, and of *Papilio echerioides*, 36 ♂s and 14 ♀s. A fine mimetic group shows the relationship, on both the upper and under surfaces of the wing, of these two Papilios to their Danaine models. It includes 2 *Amauris niavius dominicanus*, with their mimics 2 *hippocoon* ♀s of *dardanus*; 2 *Danaida chrysippus*, with their mimics 2 *trophonius* ♀s of *dardanus* (one of these latter had been presented in 1905 by G. A. K. Marshall, Esq.); 2 *Amauris echeria lobengula* and 2 *Am. albimaculata*, with their mimics 2 *cenea* ♀s of *dardanus* and 2 ♀s of *P. echerioides*. Two ♂s of the latter species were added for comparison. The whole of this group was captured in or in the immediate neighbourhood of the small patch of virgin forest on Mt. Chirinda.

The *Acraeinae* of this great donation have also been incorporated, 208 having been permanently catalogued and large numbers of additional specimens added to the University Collection. This fine series includes 4 *Acraea rabbaiae*, 2 *satis*, 4 *machequena*, 15 *egina areca*, 3 *acrita*, 18 *aglaonice*, 28 *igola*, 26 *escbria* including fine varieties of ♀, 8 *johnstoni*, 7 *Planema aganice*. The whole series gives a very fine idea

of the species of *Acraeinae* found in this interesting locality and the proportions which obtain between them.

Thirty pupa-cases of *Pseudacraea imitator*, 21 of *Ps. lucretia*, and 4 of *Ps. boisduvali trimenii* from the Durban district, presented by the late A. D. Millar, Esq., of Durban, have been added to the collection.

Four specimens of *Teracolus aldabrensis* (Jan. 1–7, 1909) from Aldabra Island were presented by J. C. F. Fryer, Esq.

A fine series of 213 American Hymenoptera were presented by G. A. James Rothney, Esq., a valuable addition to the splendid collection given and continually enriched by the donor.

Six *Ornithoptera*, 1 *Papilio*, and 3 *Kallima* from various localities were presented by the Hon. Walter Rothschild, F.R.S.

Additions to the Collections in 1911.

A large number of specimens presented in 1911 have been catalogued and incorporated in 1912. The additions to the British collections are especially notable.

Of the splendid collection presented in 1911 by W. A. Lamborn, Esq., the following very small proportion has been incorporated. All specimens were captured or bred by the donor in the neighbourhood of Oni Camp, 70 miles E. of Lagos.

Thirty-seven *Papilioninae*, including *P. dardanus. cypraeofila, cynorta*, and *menestheus*. Many of the specimens were bred, and the precise pupa-cases have been preserved and are now labelled so as to record the relationship with the respective imagines. The pupa-cases of *P. menestheus* and *policenes* are especially important; for the donor has proved that in these species there is a marked power of colour adjustment to the immediate environment of the pupa. The Papilios also include, for the bionomic series, a ♂ and ♀ *P. cynorta* with injuries probably inflicted by enemies, and an example of *P. demodocus* which, while *in cop.* with another, was being eaten by a Mantis.

One bred example of *Acraea rogersi lamborni* and 3 of

A. admatha with their respective pupa-cases, and, for the bionomic series, a ♀ *A. zetes*, which was seized and then dropped by a lizard.

The *Acraeinae* collected in the Entebbe district in 1909–11, and presented by C. A. Wiggins, Esq., M.R.C.S., F.E.S., D.P.M.O. of the Uganda Protectorate, were, with the exception of those set aside for the bionomic series, catalogued under their separate years and incorporated in the collection. For 1909, 123 specimens were incorporated; for 1910, 100; for 1911, 11. In order to avoid repetition all are gratefully acknowledged under a single year—1911. Among the species are *A. pentapolis, admatha leucographa, insignis, caecilia, viviana, orina, pelasgius, semivitrea, orestia, quirinalis, perenna,* and *althoffi*. The series includes a single ♂ of *Planema aganice montana*, which, although very rare, just enters the district from its metropolis in the East. It is hoped that the remainder of the splendid collection presented by the generous donor will soon be incorporated.

The following additions to the bionomic series were presented by C. F. M. Swynnerton, Esq. The specimens were taken in 1911 on the outskirts of Chirinda forest, Gazaland, S.E. Rhodesia:—a *hippocoon* ♀ of *P. dardanus*, taken by a native collector (Sept. 8) from a M'lanje Bulbul (the head was wanting, and the wings showed symmetrical injuries similar to those often seen in living butterflies); the wings of the dry-season form of *Precis archesia* and the fragments of a cockroach, *Deropeltis* sp., taken (June 25) from a spider's web. These examples are recorded in Proc. Ent. Soc., 1911, pp. lxxii–lxxiii.

Seven butterflies from Kibigori, about 20 miles E. of Kisumu, British East Africa, and an example of the rare Danaine butterfly *Amauris ansorgei* (June 18), Uganda Railway, high up on the Mau Escarpment, were presented by the captor, W. M. Griess, Esq. The needs of the Hope Department were kindly brought to the notice of the donor by Rev. C. F. Thornewill, M.A.

Thirteen butterflies from various African localities were presented by the late Herbert Druce, Esq., F.L.S.

The following African insects were presented by the Entomological Research Committee of the Colonial Office:—26 Diptera, 15 Lepidoptera Heterocera, 8 Orthoptera, 17 Coleoptera, 14 *Flatidae* (Homoptera), and 117 Hymenoptera. The specimens had been captured in N.E. Rhodesia, B. C. Africa, and B. E. Africa by S. A. Neave, Esq., in Uganda by C. C. Gowdey, Esq., B.Sc., and in S. Nigeria by Dr. J. J. Simpson. The Hymenoptera have been named in the British Museum by Rowland E. Turner, Esq., and G. Meade-Waldo, Esq.

A collection from the Comoro Islands (1911), purchased from Mr. G. F. Leigh, F.E.S., contains the following specimens:—from Mayotta, 63 butterflies, 20 moths, and 6 Longicorn beetles; from Johanna, 55 butterflies, including 9 *Amauris ochleides affinis* and 3 *Acraea esebria* f. *masaris*, and 28 moths; from Grand Comoro, 444 Lepidoptera, including very long series of Satyrine species, of *Acraea ranavalona*, *Mylothris ngaziya*, and *Euchromia madagascariensis*, 8 *Am. ochleides affinis*, 17 *Neptis comorarum*, and 3 *Acraea esebria* f. *masaris*. Many duplicates will be available for exchange.

The three fine collections of Hymenoptera presented by G. A. James Rothney, Esq., F.E.S., have now been labelled and placed in vacant drawers at the end of the cabinet containing the Rothney Collection of Oriental Hymenoptera. They consist of the following series:—(1) 1,100 specimens purchased from Hermann Rolle of Berlin: the localities are very varied—Madagascar and the surrounding islands, many parts of Africa, Formosa, China, India, Ceylon, Java, New Guinea, Cuba, &c.; (2) 732 specimens from the Van de Poll Collection, mostly from Java; (3) 605 specimens collected by F. P. Dodd in Queensland, principally at Townsville and Kuranda, near Cairns. The collection also contains, from the same locality, 28 Diptera, 20 Neuroptera, 64 Rhynchota, 37 Orthoptera, 26 ova, larvae, pupae, &c., and 35 Arachnids. The numbers are larger than those given, as two or more specimens on one card have only been catalogued as one.

Six larval cases of Psychid moths collected by Mrs. J. S. Hooker at Kirkee, near Poona (1911), were presented by the Rev. J. W. B. Bell, M.A., Hertford College.

One hundred and fifty-six butterflies, 12 moths, and 2 Odonata, S. Jacintho Valley, 7 miles N.E. of Theophilo Ottoni, Minas Geraes, E. Brazil (August, 1907–May, 1908), were presented by the captor, F. Birch, Esq. The specimens are greatly wanted by the Department, in which this interesting part of Brazil is barely represented. The series of specimens belonging to the beautiful Neotropical Nymphaline genus *Catagramma* are very fine. Among the *Pierinae* Dr. Dixey directs attention to 2 *Leucidea brephos*, an interesting form probably allied to *Terias*. Dr. Karl Jordan kindly arranged with the generous donor that these valuable specimens should be presented to the Department.

Two *Salius* and 3 *Pompilus* from Hyéres (March, April, 1911) were presented to the bionomic series by the captor, Dr. T. A. Chapman, M.D., together with examples of the Reduviid bug *Pirates hybridus* from Amélie-les-Bains (April, 1911). The specimens show the resemblance of the black red-banded Hemipteron to a common pattern of the Pompilid group of Fossorial Hymenoptera, as described by the donor in Proc. Ent. Soc., 1911, pp. xxix–xxx.

Dr. Chapman also presented 2 female *Polistes gallicus* with the young comb over which they were resting beneath a stone (Hyères, March 29, 1911). The comb had but 8 cells, 5 of which contained eggs. The association of two females with a nest at this early stage is remarkable (ibid., p. xxx).

Three specimens of *Nomiades arion* from N. Cornwall (July 3–4, 1911), 25 moths from the Forest of Wyre, Worcestershire (April, 1911), and 34 moths from the New Forest (May, June, 1911) were presented to the general collection by the captor, F. C. Woodforde, Esq., B.A., Exeter College.

Four specimens of the Zygaenid moth *Procris geryon*, Dovedale, Derbyshire (June, 1911), were presented by the captor, E. D. Bostock, Esq.

Additions to the British Collections in 1911.

No more interesting and valuable addition to the bionomic series has ever been made than the large collection by which

Mr. A. H. Hamm, of the Hope Department, has thrown so much light upon the courtship of the Empid flies.

Results so surprising require abundant proof, and it will be admitted by any one who studies the series that the material both of *Empidae* themselves and the insects captured or objects seized by them, is of immense extent and most carefully collected, embodying the results of a large number of original observations and most ingenious experiments. The whole of Mr. Hamm's researches were carried out in the neighbourhood of Oxford. The great labour of labelling and cataloguing was finished by Mr. Collins in time for exhibition at the Entomological Congress in August, 1912, where the collection was studied with keen attention and interest. The catalogue numbers—591 in 1908, 771 in 1909, 718 in 1910, and 969 in 1911—large as they are, give a very inadequate idea of the material; for the catalogue is of mounts rather than specimens, of which many are constantly carried on a single card. The collection includes many specimens captured and presented by Mr. Hamm's son, Mr. C. H. Hamm.

A part of the results has been already published in the "Entomologist's Monthly Magazine" for 1908, p. 181, and 1909, pp. 132 and 157; but the most novel and interesting observations and conclusions—those obtained with the genus *Hilara*—are made known for the first time in the following brief account of Mr. Hamm's gift. The full and detailed account awaits publication until numbers of obscure and minute insects—Dipterous captors and prey chiefly Dipterous—have been satisfactorily worked out.

The collection has been classified by Mr. Hamm so as to illustrate his conclusions, the species being arranged in groups, each representing a definite evolutionary stage in the use of prey—first and lowest as food devoured by both sexes without relation to pairing, then as a gift provided by the male and devoured by the female during pairing, finally—as it were an ornament or plaything—no longer eaten by the female, but acting as a lure and a stimulus. In this last stage the prey is often replaced by some vegetable fragment which is quite unsuitable as food. The climax of this line of evolution is

reached in an elaborate cocoon spun by the male around the prey and replacing the latter as an object of attraction. This replacement is self-evident in many examples studied by Mr. Hamm; for in these there was nothing but an empty cocoon, the prey having probably been lost during the process of construction.

There are strong reasons for the belief that the last stage has been reached through the second and the second through the first, but this inference must not be extended further and made to apply to the species themselves.

Empidae and their prey in relation to courtship.

I. Prey devoured by both sexes independently of pairing.

A. *Tachydromia* (*Tachydrominae*). Prey very nearly always Dipterous and often belonging to the genus *Tachydromia*, perhaps sometimes to the same species as the captor. The female *in copula* has very rarely been found with prey. 1908—ninety catalogued specimens (or mounts), of which 17 were captured by Mr. C. H. Hamm; 1909—eighty-six, of which 2 were captured by Mr. C. H. Hamm; 1911—thirty.

B. *Hybos* (*Hybotinae*). Prey generally Hymenopterous. 1908—eighty-four, of which 26 were captured by Mr. C. H. Hamm; 1909—two; 1911—six.

C. *Empis trigramma*, *punctata*, and *scutellata* (*Empinae*). A little group of related species with habits very different from those of the rest of the genus so far as it has been studied. 1909—sixty-three.

II. The prey provided by the male is devoured or sucked by the female during copulation.

A. *Pachymeria* (*Empinae*). The prey always Dipterous. 1908—one hundred and ten; 1909—one hundred and seventy-eight.

B. *Rhamphomyia* (*Empinae*). The prey nearly always Dipterous. 1909—three; 1910—two hundred and fifty; 1911—sixty-five.

C. *Empis* (*Empinae*). Small species as yet undetermined. Prey nearly always minute Diptera, chiefly *Cecidomyia* and *Psychodes*. 1909—two; 1910—fifty-five; 1911—one hundred and three.

D. *Empis tessellata*. Prey very varied, but always Dipterous. 1908—two; 1909—two hundred and twenty-four; 1910—twelve; 1911—thirty-three.

E. *Empis opaca*. Prey like that of *tessellata*, but mainly of the genus *Bibio*. 1909—one hundred and sixty-eight; 1910—forty-six; 1911—forty.

F. *Empis livida*. Prey more varied than that of any other species of the genus, but still chiefly Dipterous. 1908—three hundred and five, of which 4 were collected by Mr. C. H. Hamm; 1909—forty-five; 1911—thirty-two.

III. The prey or object provided by the male is not devoured by the female, but becomes as it were an ornament or plaything providing some indispensable stimulus.

A. *Hilara* (*Empinae*). Many species as yet undetermined. All the species fly over water, and the prey or other object is always picked up from its surface by the male *Hilara*. The males take floating insects of all kinds—sometimes specially Diptera, sometimes Aphids—scales off overhanging trees or other fragments of plants. Some of the species will accept almost any floating object, while others seem to restrict themselves to particular insects, such as *Aphidae*. When the object is very heavy the male, after seizing it, spins round with great velocity till the load rises on a cone of water and is finally lifted from the apex. In Mr. Hamm's experiments disabled Diptera of the genus *Chironomus*, &c., stamens of buttercups, and ray florets of daisies strewn on the water were soon taken by the males and afterwards found in the possession of the females. Pairing invariably occurs upon the wing, but numbers of specimens show that a sweep of the net through the swarm at first catches nothing but males carrying the objects that had been strewn on the water, while a later sweep catches pairs still carrying the same objects. The specimens illustrating this investigation are all carefully

labelled with the hour and minute at which the different samples were secured.

Mr. Hamm's admirable experiments also enabled him to determine that the females carry the objects provided by the males; for although they are never retained when the pairs are captured, the white florets or the yellow stamens can be seen hanging from the lower *Hilara* of each flying pair, and the lower is invariably the female.

The climax is reached in the males of certain species of *Hilara* which envelop the prey or other minute object in a cocoon, varying greatly in complexity, but in the most extreme cases of striking beauty and regularity. The cocoon is spun upon the wing, so that the method of its construction cannot be followed. Captured individuals are often found to have extruded a viscid globule—probably the material out of which the cocoon is spun. There can be little doubt that in these extreme cases it is the cocoon itself which acts as a stimulus to the female, although the minute and almost invisible object usually enclosed in it, but sometimes dropped, is the stimulus which incites the male to spin. Cocoons that have been dropped, probably after pairing, are constantly picked up and used over again by other males.

These novel and surprising conclusions, obtained as the outcome of Mr. Hamm's energy, resource, and power of accurate observation, are illustrated and confirmed by an immense mass of mounted material, catalogued under 355 numbers in 1910 and no less than 660 in 1911.

The collection of British Diptera greatly benefited, as in many previous years, by the generous kindness of Col. J. W. Yerbury, no less than 740 specimens having been catalogued and incorporated. The dates of capture range from 1894 to 1910, and localities from the following counties are represented:—Inverness, Nairnshire, Perthshire and Sutherland, Herefordshire, Gloucestershire, Devon, Dorset, Hampshire, Kent, Surrey, Essex, Suffolk. Many Diptera from a few localities in N. Wales and from Porthcawl in S. Wales are also present. The species belong principally to the *Anthomyidae*, *Sepsidae*, *Geomyzidae*, *Ephydridae*, *Drosophilidae*, and

Agromyzidae. The great majority have been named by J. E. Collin, Esq., and the determinations have been in all cases affixed to the specimens. Col. Yerbury also presented a series of 4 specimens and 3 puparia of the Tipulid *Dictenidia bimaculata*, bred (May, 1910) by Dr. David Sharp, F.R.S., in the New Forest. This fine insect is a very welcome addition to the British Collection.

For the collection of British Hymenoptera Col. Yerbury presented a ♂ and ♀ of *Mutilla europaea* and a ♀ *Pompilus rufipes*, from Studland, Dorset (1910), for the general collection 5 Diptera from Cascaes, Portugal (1896), and for the bionomic collection two Dipterous predaceous insects with Dipterous victims—a ♀ *Caricea tigrina* with a ♀ *Coenosia* (Porthcawl, S. Wales, 1903) and *Ophyra leucostoma*, with prey as yet unnamed (Christchurch, Hampshire, 1897).

The following valuable additions to the British collections are due to the kindness of F. C. Woodforde, Esq., B.A., Exeter College. The specimens, unless otherwise described, were captured or bred by the donor.

One *Asteroscopus nubeculosa*, bred in April, 1911, from eggs laid by a female captured at Rannoch in March, 1908, by L. G. Esson, Esq. The species is apt to remain for some years in the pupal state.

Seventy-seven moths, 1 *Gonepteryx rhamni*, and 1 Dipteron, taken April, 1911, in the Forest of Wyre, Worcestershire. Among the moths is a fine set of *Taeniocampae* taken at Sallow, including *T. opima* and *T. miniosa*.

Six dark forms of *Tephrosia crepuscularia* (*biundularia*), bred May 5, 1911, from a female captured May 28, 1910, at Cannock Chase, Staffordshire.

One dark form of *Boarmia repandata*, bred June, 1911, by B. G. Adams, Esq.

Fifteen butterflies, 170 moths, including fine series of *Boarmia cinctaria*, *Scodiona belgiaria*, and *Pachycnemia hippocastanaria*, 14 Diptera, including *Empis tessellata* and its Dipterous prey *Leptis scolopacea*, 4 Neuroptera and 6 Hymenoptera Parasitica, bred from Lepidoptera, from the New Forest, 1911.

Nine butterflies, including 5 *Nomiades arion*, 37 moths, including 1 ♀ *Agrotis lunigera*, and 20 mixed insects, including a set of the Melolonthid beetle *Rhizotrogus ochraceus*, only recently recaptured and confirmed as British, from N. Cornwall (1911). Two of the moths were bred in N. Cornwall from ova laid by a female captured in the New Forest and 2 from a female taken at Sutton Coldfield.

One *Lycaena* (*Cyaniris*) *argiolus*, May 11, 1911, from Clevedon, Somerset.

A fine collection of British insects of many groups, captured 1909–11 in N. Devon, from several localities, almost exclusively in the neighbourhood of Mortehoe, was presented by the captor, Dr. G. B. Longstaff, D.M., F.R.C.P., New College, Oxford.

The collection is made up of the following:—Hymenoptera, considerably over 113, inasmuch as two or more are often mounted on the same card; Diptera, 327, including a fine series of *Syrphidae*, of which all the difficult or obscure species were determined by the late G. H. Verrall, Esq.; Neuroptera, 5; Coleoptera, over 83; Rhynchota, over 33; Orthoptera, 14. The collection also includes the following specimens for the bionomic series:—5 *Empidae*, with Dipterous prey of the following kinds respectively—an Anthomyid, a Dolichopid, *Siphona geniculata*, *Syrphus ribesii*, *Lucilia caesar*; 1 *Scatophaga stercoraria*, with Dipterous prey; 2 *Tenthredinidae*, one with Dipterous prey, one with Tenthredinid prey; the Tenthredinid *Allantus arcuatus* together with a ♂ humble bee, *Psithyrus barbutellus*, a much larger insect, which it repeatedly tried to drive off a flower-head of Scabious; 2 *Bombus agrorum*, a common humble bee, and 2 *Arctophila mussitans*, a much rarer fly. The bee and fly may be seen together on the same patch of *Centaurea nigra*, although these particular specimens were not so taken.

Three ♂ and 14 ♀ *Clisiocampa castrensis*, bred July 24–31, from larvae found, June 26, mostly on *Statice limonium*, at Rushenden Spit, Queenborough, Sheppey, were presented by Commander J. J. Walker, Hon. M.A., F.E.S. The larvae were subsequently fed on apple at Oxford.

A female *Parasemia plantaginis*, captured June 3 in Tubney Wood near Oxford, together with 9 ♂ and 2 ♀ bred from her eggs, was presented by Commander Walker. The eggs were laid about June 4–8, and hatched about June 14. The larvae were fed on lettuce, and the moths emerged Aug. 26–Oct. 14 (Ent. Mo. Mag., 1911, p. 260).

Nine specimens of the Zygaenid moth *Procris geryon*, Dovedale, Derbyshire (June, 1911), were presented by the captor, E. D. Bostock, Esq.

Ten specimens of the Zygaenid *Z. meliloti*, Wood Fidley, New Forest (July 6, 1911), were presented by the captor, the Rev. G. E. C. Osborne.

A nest of the Dartford Warbler (*Melizophilus provincialis*), taken in a gorse-bush, at Blackheath, Guildford, in 1898, after the flight of the young birds, was presented by Mrs. Alfred Hewitt, who, as Miss Margery Moseley, had made the observation and preserved this evidence of the breeding of the species in England.

Additions to the Collections in 1912.

The following collections have not yet been incorporated, although some of them have been labelled. It is hoped that they will be acknowledged in the next year's Reports:—A collection of butterflies from Trinidad by Guy A. K. Marshall, Esq.; of Insects of many Orders from New Guinea by G. N. Carson, Esq.; of Lepidoptera from Bwaidogo Island at the South-East end of New Guinea by D. Jenness, Esq., B.A., Balliol College; the chief part of the material of his paper (Part II, No. IX) in the Trans. Ent. Soc. 1912, by Lieut.-Col. N. Manders, R.A.M.C., F.Z.S., F.E.S.

A very interesting collection of ants from the neighbourhood of Buluwayo (1911–12) was presented by the captor, G. Arnold, Esq., M.Sc., A.R.C.S., F.E.S., curator of the Rhodesian Museum, Buluwayo. Many of the species are new to science, having been only recently described by Prof. A. Forel. The donor has also presented a few Australian and Californian ants and a few other South African

Aculeates, the latter his own captures. A full account, with the numbers of specimens, will appear in a future Report.

The exceedingly fine and complete collection of British East African butterflies (1905–12), presented by the captor, Rev. K. St. Aubyn Rogers, M.A., Wadham College, has now been catalogued and incorporated. The generous donor gave extremely kind and efficient assistance in this task, by himself undertaking the arrangement of the African *Lycaenidae*, during a visit to Oxford in the summer of 1912. The immense extent of the gift may be inferred from a glance at the following pages, where the collection, although catalogued under the separate years, is acknowledged as a whole. The University Collection now possesses, in consequence of this great gift, one of the finest, if not the finest series of British East African butterflies in any museum. All possess the most excellent data of time and place. A small but valuable collection of moths and of beetles, as well as many specimens of great bionomic interest, are also included.

The localities are arranged in the following order:—(1) The coast district in the neighbourhood of Rabai, 14 miles N.W. of Mombasa; (2) The Uganda Railway as far as Voi and then diverging to the Hills of Taita, Taveta, and Kilimanjaro; (3) The Uganda Railway W. from Voi, thus reaching the Nairobi, Fort Hall, and Kenia districts.

Rabai (about 700 ft.), 14 miles N.W. of Mombasa.

1906—fifty butterflies and one moth, including the unique ♀ type of *Pseudacraea rogersi* and the mimetic group represented in figs. 5, 6, 7 of Plate XXIX, Trans. Ent. Soc., 1908. The model *Mylothris agathina* and its two mimics *Belenois thysa* ♀ and *Leuceronia argia* ♀ were captured together on the same day, June 23.

1907—one hundred and twenty-two butterflies, 27 moths, and 1 Asilid fly (*Alcimus*) with its Hesperid prey. The fine series of butterflies includes 4 ♂ *Ps. trimenii*, one of them a var. described by Mr. Roland Trimen, Hon. M.A., F.R.S., in Trans. Ent. Soc., 1908, p. 553, 2 ♂ *Euxanthe tiberius*, 6 ♂ *E. wakefieldi*, 1 ♀ *Euryphene senegalensis*, 1 ♂ *Acraea satis*

2 ♀ *Alaena picata*, 2 *Lycaenesthes lasti* (capt. *in cop.*), 5 dark forms of *Teriomima freya*, 1 yellow ♀ *Teracolus hetaera*, 1 pair *Ter. regina*, 1 *Pap. kirbyi*, and, for the bionomic series, a Satyrine showing symmetrical injuries of the wings, and several members of the two great E. African black and white groups ranged round the Danaine butterflies *Amauris niavius dominicanus* and *Amauris ochlea* respectively. Two of these are figured in Trans. Ent. Soc., 1908, Pl. XXVI, viz. the model *dominicanus* (fig. 1) and one of the rarest of its mimics *Hypolimnas usambara* (fig. 2). Model and mimic were captured on the same day, Sept. 15.

1908—twenty-five moths and 132 butterflies, including 3 *Physcaenura leda*, 1 *Mycalesis mandanes*, 2 ♂ *Euxanthe tiberius*, 6 ♂ *E. wakefieldi*, 3 ♂ *Euryphene chriemhilda*, 2 ♂ 2 ♀ *E. senegalensis*, 2 *Hypolimnas usambara*, 1 ♂ 1 ♀ *Charaxes azota*, 1 ♂ *Ps. trimenii* (var.), 1 ♂ 1 ♀ *A. rabbaiae mombasae*, 1 ♂ *A. satis*, 7 *Teriomima subpunctata*, 12 *T. micra*, 5 *Telipna rogersi*, 2 pairs *Pentila amenaida* (capt. *in cop.*), 1 ♂ *Virachola caerulea*, 1 *Spindasis kallimon*, 1 *Iolaus pallene*, 1 fine yellow ♀ *Belenois thysa*, 3 ♂ *Pap. dardanus tibullus*. In addition to the above, pupal cases and larval skins and heads of *Charaxes saturnus*, *castor*, and *azota*, together with the following additions to the bionomic series :—two butterflies with injuries probably caused by enemies, 1 Asilid and its prey, an Andrenid bee, 1 *Pardopsis punctatissima* and *Pentila amenaida* captured on the same day, Aug. 15.

1910—one hundred and four butterflies, including 4 ♂ *E. tiberius*, 1 ♀ *E. wakefieldi*, 1 ♂ 1 ♀ *Ps. trimenii*, 1 ♂ *Charaxes bohemanni*, 1 ♀ *Ch. boueti lasti*, 1 *Ch. violetta*, 1 *Euryphura achlys*, 1 ♂ *A. satis*, 2 *Iolaus pallene*, 1 ♀ *Alaena picata*, 3 *Teriomima subpunctata*, 2 *T. micra*, 8 *T. freya*, 2 *Telipna rogersi*, 5 *Pentila peucetia*, 1 *Phrissura nagare*, 3 *Pap. porthaon*, 1 *P. colonna*, 1 *P. constantinus*, 1 *Gorgyra minima*, 1 *Coenides cylindra*, 1 ♂ *Ploetzia cerymica*; 10 moths, including one pair *Cartaletis lybissa* (capt. *in cop.*); 2 Asilid flies with their prey, a ♂ *Catopsilia florella* and a Bombylid fly respectively; also the ♀ parent of the *inaria* form of *Hypolimnas misippus* with

its 35 ♀ offspring, all of which were of the type or *misippus* form—a result that can only be explained by supposing that the *inaria* ♀ parent had paired with a ♂ carrying the tendencies of *misippus* and that *misippus* is a Mendelian dominant. The result of the experiment is published in Proc. Ent. Soc., 1911, p. xliv. The material of an experiment upon a company of larvae of *Belenois severina* is also included, 7 ♂ and 2 ♀ being reared from larvae fed on young leaves, 15 ♂ and 8 ♀ from larvae fed on old leaves; both sets were accidentally starved Sept. 15–17. Those fed on the old leaves grew more slowly than the others and were stunted. A single *Teracolus*, reared (Sept. 6) from a larva fed on old dry leaves, was also included, together with a wild example of the same species for the purpose of comparison.

1911—twenty-four moths, including 1 *Weymeria athene*—an *Agaristid* mimic of *Cartaletis*, 84 butterflies, including 1 ♂ *Charaxes bohemanni*, 7 ♂ 1 ♀ *Ps. trimenii* (the ♂s forming a transition into the western form as regards the absence of the orange subapical bar to the fore wing), 1 pair *Neptidopsis platyptera* (capt. *in cop.*), 2 *Acraea cuva*, 1 *A. zonata*, 1 ♀ *A. satis*, 4 ♂ 1 ♀ *Hypolycaena* sp. near *buxtoni*, 1 *Spindasis kallimon*, 1 *Iolaus lalos*, 1 *Virachola dariaves*, 2 *Teriomima micra*, 1 *T. subpunctata*, 2 *Lycaenesthes adherbal*, 1 pair *Phrissura lasti* (capt. *in cop.*), 1 *Phrissura nagare*, 1 ♂ 1 ♀ *Ter. daira*, 2 *Pap. kirbyi*, 1 ♂ *P. dardanus tibullus*, 1 *Gorgyra johnstoni*. Also an Asilid fly and its prey, a Coreid bug. Furthermore, the specimens from Rabai included 2 ♀ parents of the type form of *Hypolimnas misippus* together with their ♀ offspring—16 all of the type form in one family, 37 of the type form and 17 of the *inaria* form in the other family. These results were published in the Proc. Ent. Soc., 1912, pp. lxxiii–lxxiv. For the bionomic series there were also included 2 *Libythea*, and 2 ♂s and 3 ♀ s of *Crenis*, migrating, March 31, 1911, owing to excessive drought and thus brought into the Rabai district, in which they are not normally found (Proc. Ent. Soc., 1912, pp. xcviii–xcix). Also *Amauris niavius dominicanus* with its mimics *H. wahlbergi* and the *hippocoon* ♀ of *dardanus* captured together May 27; 1 *Amauris ochlea*,

1 *Neptis agatha*, 1 *Ps. lucretia*, 1 ♂ 1 ♀ *H. deceptor*, 1 ♂ 2 ♀ *Euxanthe wakefieldi*, all captured June 17; also 1 ♂ *Acraea natalica*, 1 ♂ *A. acara*, 1 ♂ *Ps. trimenii*, captured April 20; also 1 ♀ *A. anemosa*, 1 ♂ *A. natalica*, 1 ♂ *A. areca*, 1 ♂ *Ps. trimenii*, captured July 1.

1912—fifteen moths, including *Weymeria athene*—a mimic of *Cartaletis*, 35 butterflies, including 2 ♂ *Ps. trimenii*, 1 *A. insignis* (with remarkable reduction of black markings), 1 ♀ *A. satis*, 1 ♀ *A. aubyni*, Eltringham (the type of the description of this sex).

The fine collection of moths, chiefly from the Rabai district, and acknowledged in the preceding paragraphs, includes three new species soon to be described by G. T. Bethune-Baker, Esq., Pres. E. S.

An interesting series of 74 Coleoptera of various groups captured (1908–1911) in the Rabai district was presented by the same generous donor. The following additional specimens with the same data have been placed in the bionomic series:—2 Coccinellid beetles of the genus *Epilachna* and 2 Pentatomid bugs with a similar pattern, 1 ♀ Mutillid and 1 Clerid beetle mimicking it in a very remarkable manner. The black abdomen of the stinging model is marked with two pairs of white spots, of which the anterior is bright and glistening, the posterior dull. The elytra of the beetle are also marked by two pairs of spots bearing the same relative brightness and so placed that they appear to occupy positions corresponding to those of the model.

Shimba (about 1,200 ft.), about 16 miles W. of Mombasa: 1907—twelve butterflies, including the unique ♂ type of *Pseudacraea rogersi*, Trimen, 1 ♂ *Euptera kinugnana*, 1 very black form of ♀ *Acraea natalica*, and 1 *Argiolaus lalos*.

Kisimani (about 500 ft.), 3 miles S.W. of Rabai, woodland and cocoa plantations: 1910—two *Hesperidae*, and, for the bionomic collection, 1 *Amauris niavius*, 1 *Hypolimnas wahlbergi*, 1 ♀ *Euxanthe wakefieldi*, 1 ♂ *P. dardanus tibullus*, all captured Sept. 17.

Changombe (about 600 ft.), 3 miles E.N.E. of Rabai, wood-

land: 1910—three *Pentila micra*, 1 ♀ *Lycaenesthes lemnos*, and 10 *Hesperidae*, especially needed by the Department.

Jimba (about 700 ft.), about 3 miles N.N.W. of Rabai: 1907—four butterflies; 1908—one ♂ *Teracolus daira*; 1909—eleven *Pierinae* (10 *Ter. daira*), an Asilid fly and its prey a dragon-fly; 1911—five butterflies.

Kaloleni (about 900 ft.), about 10 miles N. of Rabai: 1906—one *Acraea*; 1912—one *Petovia dichroaria* (*Geometridae*).

Kaya Kambi (about 600 ft.), about 12 miles N. of Rabai: 1906—one ♀ *Euxanthe tiberius* and 1 moth *Pitthea famula.*

Jibana (about 600 ft.), about 14 miles N. of Rabai: 1906—one ♀ *Pinacopteryx spilleri.*

Chalani (about 600 ft.), about 15 miles N. of Rabai: 1906—one *Acraea insignis*: 1908—one ♂ *Charaxes violetta*; 1911—one ♂ *Charaxes etheocles*, 1 *Epamera*, 1 *Pinacopteryx.*

Chonyi (about 400 ft.), about 15 miles N.E. of Rabai: 1908—eight butterflies.

Weruni (about 700 ft.), about 20 miles N. of Rabai: 1911—one fine ♂ *Argiolaus silas*, var. *lalos.*

Ndzovuni (about 300–600 ft.), about 25 miles N. of Rabai; dense forest: 1906—one moth and 27 butterflies, including 2 ♂ *Acraea cuva*, 1 *A. rabbaiae mombasae*, 1 ♀ *Pseudacraea trimenii*, 1 ♀ *Epamera mermis*, 1 *Teracolus hetaera* (white form), 1 pair *Phrissura lasti* (capt. *in cop.*), 1 pair *Belenois thysa* (capt. *in cop.*), 1 *Rhopalocampta sejuncta*: 1907—six butterflies, including 2 *Pentila peucetia*, and the Geometrid moth *Paraptychodes tenuis*: 1908—one moth and 18 butterflies, including 1 ♀ *Aterica galene* with fulvous patch on hind wing, 1 *A. satis*, 1 *A. rabbaiae mombasae*, 1 ♀ f. *hippocoon* of *P. dardanus tibullus*, 1 *Parosmodes moranti*, 1 *Rhopalocampta keithloa*: 1910—six butterflies, including 1 ♂ *Charaxes lasti* and 2 *Pentila rogersi*: 1911—one moth, the type of a new species of *Paraptychodes* (*Geometridae*), soon to be described by Mr. L. B. Prout, F.E.S., and 39 butterflies, including one pair *Physcaenura leda* (capt. *in cop.*), 2 *Neptis trigonophora*, 2 *Ps. trimenii* (1 with hardly any subapical ochreous bar to the fore wing), 1 ♂ 1 ♀ *Charaxes azota*, 1 ♂ 2 ♀ *Ch. cithaeron*, 1 ♂ *Ch. pithodorus*, 3 ♂ 2 ♀ *Ch. lasti*, 2 *Euphaedra eleus*, 1 ♂ *Acraea*

satis, 1 ♀ *Iolaus mermis*, 3 ♂ 1 ♀ *Alaena picata* (specimens which proved for the first time that these two butterflies with entirely different upper-side pattern are the sexes of the same species. The ♂ had been independently described by Suffert, in 1904, as *Al. rollei*, which now sinks to *picata*, described by Miss E. M. Sharpe in 1896), 1 ♀ *Ter. eris* (an unusual yellow form), 1 ♀ form *hippocoon* of *P. dardanus*, 1 *P. constantinus*, 1 *Caprona pillaana*, also one Asilid fly (*Alcimus*) and its prey, a *Teracolus*: 1912—one *Euryphene chriemhilda*, 1 *Euryphura achlys*, 1 ♂ *A. satis*.

Godoma (about 400-500 ft.), about 30 miles N. of Rabai, some forest: 1909—one *Deloneura ochrascens* and 1 *Teriomima micra*: 1911—one *Pentila amenaida*.

Kaya Kauma (about 500 ft.), about 35 miles N. of Rabai: 1906—one moth and 10 butterflies, including 1 *Teriomima subpunctata* and 1 *Papilio colonna*: 1907—five butterflies: 1908—eight butterflies, including 1 ♀ *Aterica galene* with rich orange-brown patch on hind wing, 1 ♀ f. *niobe* of *P. dardanus tibullus* (the markings ochreous rather than fulvous), 1 *Iolaus lalos*: 1912—one ♂ 1 ♀ *Acraea braesia*.

Mwaeba Hill (about 700 ft.), about 35 miles N.N.W. of Rabai: 1906—nine butterflies, including 2 Acraeas of a new species recently described by Mr. Eltringham, M.A., New College, F.E.S., as *A. aubyni*, 1 *A. rabbaiae mombasae*: 1907—seven butterflies, including the ♂ type of *Acraea aubyni*, Eltringham.

Giryama Country (500-700 ft.), about 45 miles N. of Rabai: 1906—seven butterflies, including 1 *Hypolimnas deceptor*, 3 *Pseudacraea lucretia*, and 1 *Acraea rabbaiae mombasae*: 1908—1 *Iolaus lalos*, 1 *Deloneura ochrascens*, 1 *Acraea zonata*.

Mleji (500-700 ft.), about 45 miles N. of Rabai: 1906—one *Acraea*: 1909—a *Mantis* with its prey, a wasp.

Vitengeni (about 400 ft.), about 50 miles N. of Rabai: 1911—one *Deloneura ochrascens*, 1 *Pentila amenaida*.

Dida Forest (about 500 ft.), Giryama Country, about 55 miles N. of Rabai: 1906—nine butterflies: 1908—1 *Ps. lucretia* and 2 ♂ *H. deceptor*, captured on the same day, Aug. 20; 1910—one ♀ *Acraea satis* and 1 Lycaenid.

Mangea (about 500 ft.), about 75 miles N. of Mombasa: 1906—twelve butterflies, including 2 ♂ *Epamera mermis*, and the following 5 members of two principal black-and-white groups captured July 17–19:—3 *Pseudacraea lucretia*, 1 *Hypolimnas deceptor*, 1 *Hypolimnas wahlbergi*.

Jilore (about 200 ft.), Sabaki River, about 80 miles N. of Mombasa and 19 W. of Malindi, forest and cultivated ground: 1906—twenty-seven butterflies, including 2 pairs of *Pinacopteryx spilleri*, 1 *Iolaus pallene*, and 1 *H. deceptor*: 1908—ten butterflies, including 1 ♀ *Ter. hetaera*, 1 ♀ *Pinacopt. liliana*: 1910—five butterflies, including 1 *Charaxes tavetensis* bred (March 7, 1910) from larva found at this locality; this species is new to the Hope Department, and has probably never been bred before: 1911—one moth and 16 butterflies, including 1 *Virachola dinochares*, 2 *Teriomima micra*, 4 *Teracolus daira*: 1912—one *Neptidopsis platyptera*, 1 *Hypolycaena*, 1 ♂ *Teracolus*.

Kaembeni (about 300 ft.), forest, about 20 miles S. of Jilore: 1908—two *Pierinae*: 1910—three fine *Teracolus protomedia*: 1911—one *Neptis*, 1 pair *Epamera mermis* (capt. *in cop.*).

Sokoki (about 200–300 ft.), open forest extending 20–30 miles S. from the Jilore-Malindi Road: 1908—seven butterflies, including 1 *Iolaus lalos*, 1 pair *Pinacopteryx liliana* (capt. *in cop.*), and, for the bionomic series, 1 *Pard. punctatissima* and 1 *Pentila amenaida* taken on the same day, August 24: 1909—one *Charaxes jahlusa*, 1 Geometrid moth: 1910—two *Lycaenidae*: 1911—thirteen butterflies, including 6 *Chloroselas pseudozeritis*: 1912—one very interesting dark variety of *Pap. philonoe*, 1 Hesperid.

Between Jilore and Malindi (probably much less than 100 ft.), forest: 1910—one ♀ f. *planemoides* of *Pap. dardanus*, captured by a native collector in August. This interesting specimen, of which the pattern exhibits certain ancestral features, is described in Proc. Ent. Soc., 1911, pp. xlii–xliv: 1911—two *Neptis*, 1 ♀ *Ps. trimenii* (thick woodland, about 100–200 ft.).

Mida (just above sea-level), about 15 miles S. of Malindi: 1912—one *Charaxes jahlusa*.

Mida-Roka (just above sea-level), about 12 miles S.W. of Mida: 1912—one fine ♂ *Virachola dinochares.*

Mtanganyiko (about 100 ft.), Kilifii Creek, S. of Malindi: 1912—one *Teracolus.*

Galana (about 100–200 ft.), about 80 miles from Rabai, N. of Sabaki River: 1911—one *Acraea damii cuva*, 6 *Deloneura ochrascens*, all of which flew out of the same tree.

Mombasa Island (just above sea-level): 1906—twenty-four butterflies, including the *albinus* form of *D. chrysippus*, 1 *Teriomima freya*, and a long series of *Pinacopteryx liliana.*

Mazeras (about 500 ft.), 12 miles N.W. of Mombasa: 1906—four butterflies, including 1 ♀ *Euxanthe wakefieldi*, 1 ♀ *Teracolus hetaera* (yellow form), and 1 *T. protomedia.*

Mackinnon Rd., about 60 miles N.W. of Mombasa: 1905—one *Acraea chilo.*

Voi Swamp (1,800 ft.), near Voi Station: 1909—six butterflies, including 1 ♂ *D. chrysippus* f. *albinus*, and 4 ♀ *A. chilo*: 1911—seven butterflies, including 5 forms of *Acraea encedon* and 1 *A. braesia.* Voi: low woodland about 1,830 ft.: 1912—one ♀ *A. equatorialis anaemia*, 1 Hesperid.

Voi Plain (about 2,000 feet), 7 miles N. of Voi Station: 1908—one *Tarucus louisae*: 1909 (at about 1,900 feet)—eight butterflies, including 2 pairs of *A. chilo*, 1 pair *Teracolus aurigineus* (capt. *in cop.*): 1911—one *Acraea equatorialis anaemia*, Eltringham (a new sub-species described in Mr. Eltringham's great monograph), 1 ♀ *A. acrita.*

Voi River (about 2,000 ft.), 7 miles W. of Voi Station, mile 100 on Uganda Railway: 1905—four butterflies, including a male *Papilio dardanus tibullus* and one *Hypolimnas wahlbergi*: 1906—three butterflies, including 1 *Pentila peucetia* and 1 wet-season form of *Precis simia* captured in the midst of a normal dry season, but in this year the rains were more than a month early: 1908—eleven butterflies, including 1 *Castalius melaena*, 1 *Tarucus louisae*, 1 *Leuceronia buqueti*, 1 ♂ 1 ♀ *Teracolus callidia*, 1 *Herpaenia eriphia*, 1 pair *Pinacopt. liliana* (capt. *in cop.*): 1909—one ♀ *A. chilo*: 1910—six butterflies, including 2 ♂ *Acraea braesia regalis*,

1 ♀ *Chloroselas pseudozeritis*: 1912—two *Teracolus*, 1 Asilid fly (*Alcimus*) with its prey, a ♂ *Belenois*.

Mwatete (about 2,800 ft.), about 15 miles W. of Voi: 1910—one *Teracolus*.

Taita (about 3,000 ft.), about 100 miles N.W. of Mombasa: 1905—five butterflies, including 1 *Precis simia*.

Taita Plain (about 1,800–2,000 ft.): 1912—one ♀ *A. equatorialis anaemia*.

Sagalla Mountain (about 3,500 ft.), Taita: 1909—one *Flata* (Homoptera) and 8 butterflies, including 1 ♀ *Acraea chilo*, 1 pair *Teracolus incretus* (capt. *in cop.*): 1910—the ♀ parent and two offspring, *Precis limnoria*.

Silalone (about 2,000 ft.), at the foot of Sagalla Mountain: 1911—one ♀ *Spalgis lemolea*.

Dabida (about 5,000 ft.), about 100 miles N.W. of Mombasa: 1905—seven butterflies, including 1 ♂ *Papilio echerioides*, 1 ♀ *Mylothris narcissus*: 1908—one Braconid and 9 butterflies, including 1 ♂ *Acraea johnstoni*, 1 *Catochrysops osiris*, 1 ♀ *Teracolus callidia*: 1910—one ♀ *Acraea johnstoni* f. *confusa* (about 3,700 ft.): 1912—one *Charaxes hansalii baringana* (about 3,700 ft.).

Kaya (about 3,300 ft.), Dabida Hills: 1911—one ♀ *Acraea johnstoni* f. *confusa*.

Wusi (about 4,200 ft.), in the centre of the Dabida Hills: 1906—one ♂ *Pap. echerioides* and 1 Hesperid: 1908—one moth and 11 butterflies, including 3 *Precis aurorina*, 4 ♂ *A. johnstoni* (1 the var. *semifulvescens*), 1 ♂ 1 ♀ *Uranothauma falkensteinii*: 1911—one moth and 5 butterflies, including 1 *Precis limnoria*, and 2 bred *Charaxes pollux*: 1912—one *A. equatorialis anaemia*, 1 Hesperid.

Kidaya (about 5,000 ft.), Dabida Hills, open country and woodland: 1911—twenty-two butterflies, including a fine series of *Belenois margaritacea*, 2 ♂ *P. echerioides*, 1 *P. menestheus*, 2 *Neptis incongrua*, 1 *Precis aurorina*.

Chawia (about 5,000 ft.), in the centre of the Dabida Hills, forest and native clearings: 1908—seven butterflies, including 1 *Rapala* sp. very near to *dariaves*, 1 *Cyclopides metis*, 1 *Pap. philonoe*: 1911—twenty-seven butterflies, including 1 *Salamis*

cacta, 4 *Neptis incongrua*, 1 ♀ *Pap. echerioides* (an interesting form with very pale hind-wing patch), 2 *Gorgyra johnstoni*, 2 *Cyclopides metis*, and, for the bionomic series, 1 *Eurytela hiarbas* and 1 *N. incongrua* captured on the same day, Feb. 16 : 1912—twenty butterflies, including a fine series of *Belenois margaritacea*, 3 ♂ *Uranothauma nubifer*, 2 ♂ *P. echerioides*, 2 *Mylothris narcissus*.

Ndegwa's (about 6,000 ft.), Dabida Hills:—1909—two *Brenthis hanningtoni*, 1 pair *Belenois mesentina* (capt. *in cop.*), an Asilid fly and its prey, a bee.

Ngangao (about 6,000 ft.), the forested peak of the Dabida Hills: 1912—thirteen butterflies, including 1 ♀ *Harma* (apparently a new species allied to *H. alcimeda*), 1 *Acraea baxteri* (extending the range of this species), 2 *Uranothauma falkensteinii* (capt. *in cop.*).

Burra (about 3,000 ft.), W. end of Dabida Hills: 1910—2 *Teracolus*, 1 *Pinacopteryx*.

Maketao (about 3,800 ft.), between Taveta and Burra: 1905—eleven butterflies, including 3 examples of *Precis simia*—1 dry-season form and 1 intermediate, taken May 25, and 1 wet-season form, June 13: 1910—three butterflies, including 1 ♀ *Charaxes etheocles* (about 3,700 ft.).

Lanjoro (about 3,000 ft.), 10 m. E. of Taveta: 1905—one Pierine.

Voi to Taveta (2,000 ft.): 1905—twenty-four butterflies, including 4 ♂ and 1 ♀ of *Acraea braesia*.

Taveta (about 2,500 ft.) : 1905—sixteen butterflies, including 2 *Hesperidae* mimetic, on the under surface, of an *Acraea*, and one Geometrid moth *Petovia dichroaria* mimicking a Lycaenid: 1906—one moth and 66 butterflies, including a fine series of *Spindasis tavetensis*, 1 ♂ *Leuceronia buqueti*, 1 ♀ *Teracolus phlegyas*, and also 1 ♂ *Acraea natalica*, with the left hind wing wanting: 1910—sixteen butterflies, including one pair *Pinacopt. liliana* (capt. *in cop.*). Also 1 Asilid fly (*Alcimus*) and its prey, a butterfly (*Pinacopteryx*).

Kilimanjaro, S.E. slopes (about 3,500 ft.), Samanga: 1905—two *Acraeinae*: slopes 1906 — sixty-one butterflies and 3 moths.

Kiu (about 4,800 ft.), mile 165 on Uganda Railway: 1908—six butterflies, including 3 *Teriomima freya*: 1909—two *Teracolus*.

Masongalene (2,900 ft.), mile 185 on Uganda Railway: 1909—three butterflies, including a curious form of *Acraea esebria*: 1911—sixteen butterflies, including 1 *Acraea cerasa*, 1 ♀ *Ter. bacchus*, 1 ♂ 1 ♀ *T. puniceus*, and 1 *Kedestes callicles*.

Mukaa Hills (about 5,800 ft.), about 30 miles E. of Machakos: 1909—five moths and 67 butterflies, including 11 worn wet-season and 1 fresh dry-season f. of *Precis sesamus*, 1 *Charaxes hansali baringana*, 8 *Acraea astrigera*, 3 ♀ *A. caecilia*, and 2 *A. insignis*.

Kibwezi (about 3,000 ft.), mile 195 on Uganda Railway: 1911—one wet-season form of *Precis simia*.

Limoru (about 7,300 ft.), mile 350 on Uganda Railway: 1909—eleven butterflies, including 1 ♀ *Acraea ansorgei*, 2 *Castalius margaritaceus*, 1 *Pap. mackinnoni*: 1910—nine butterflies, including 2 *Pap. mackinnoni*.

Kijabe Forest (about 7,000 ft.), on Uganda Railway, Kikuyu Country: 1907—two moths and 72 butterflies, including a fine series of *Uranothauma cordatus*, 1 ♀ *Epamera sidus*, many *Mylothris neumanni*, showing much variation, 5 *Pap. mackinnoni*, 3 ♂ 4 ♀ *P. jacksoni*, 1 *P. bromius chrapkowski*, and, for the bionomic series, 1 *D. chrysippus* f. *dorippus* and 1 ♀ *Precis westermanni*, taken respectively Aug. 3 and Aug. 6, 1906: 1909—three *Picrinae* and 1 ♀ *Pap. jacksoni*.

Nairobi (about 5,500 ft.): 1907—fifty-one butterflies, including 1 *Tirumala formosa*, 4 *Mycalesis mandanes*, 1 *Acraea johnstoni* f. *semifulvescens*, 4 *Castalius margaritaceus*, 1 *C. gregorii*, and, for the bionomic series, several members of the mimetic group with *Amauris albimaculata* as its centre, viz. *Papilio dardanus* ♀ f. *cenea*, ♀ *P. jacksoni*, and ♀ *P. echerioides*. These examples include the originals of all the figures except No. 4 on Plate XXVIII in Trans. Ent. Soc., 1908: 1908—one moth and 56 butterflies, including 1 ♂ *Mycalesis mandanes*, 7 ♂ *Lachnoptera ayresi*, 10 *Acraea orestia* (1 pair capt. *in cop.*), 1 *Castalius margaritaceus*, 13 *Phrissura isokani* (2 pairs capt. *in cop.*), 1 ♂ 3 ♀ *Pap. phorcas*, 1 ♂, 1 *trimeni* ♀ f. (very

large), 1 *cenea* ♀ f. of *Pap. dardanus*, 3 *Rhopalocampta unicolor*, 1 *Celaenorrhinus bettoni*: 1909—two moths and 14 butterflies, including 1 *Castalius margaritaceus* and 1 *Pap. nobilis*: 1911—twenty-four butterflies, including 1 *Pap. nobilis*, 1 *Acraea cerasa*, 5 *Lycaenesthes lemnos*, 1 *Precis aurorina*.

Kabeti (about 6,400 ft.), about 8 miles N.W. of Nairobi: 1907—six butterflies, including 1 *Cupido stellata*: 1909—one *Teracolus*.

Between Thika River and Nairobi (about 5,000 ft.), on the Fort Hall road: 1907—ten butterflies.

Thika River (about 5,500 ft.), about 30 miles N. of Nairobi on the road to Fort Hall: 1907—six butterflies.

Kikuyu (about 5,000-6,000 ft.), about 30 miles N. of Nairobi: 1907—one butterfly; 1909—(6,700 ft.) sixteen butterflies, including 2 ♀ *Precis westermanni*, and 1 ♀ *Pap. jacksoni*; 1911—eight butterflies, including 1 *Pap. nobilis* and 1 *P. phorcas*.

Thiba River (about 4,200 ft.), between Embu and Fort Hall: 1909—four *Pierinae*.

Tana River (about 4,000 ft.), on the Fort Hall to Embu Road: 1911—four butterflies.

Tuso (8,000 ft.), about 25 miles W. of Fort Hall: 1907—eight butterflies, including 1 *Neptis incongrua*, 1 *N. woodwardi*, and 1 ♂ *Mylothris neumanni*; 1909—one *Neptis woodwardi* (about 7,000 ft.).

Mogoiri (about 8,000 ft.), 15 to 25 miles W. of Fort Hall: 1907—one moth and 26 butterflies, including 2 *Neptis woodwardi*, 3 *Brenthis hanningtoni*, 2 ♂ *Teracolus elgonensis*, 3 ♂ 1 ♀ *Mylothris neumanni*: 1909—one ♂ *A. asboloplintha rubescens*, 1 *Epamera arborifera* (about 6,500 ft.).

Weithaga (about 6,000 ft.), 15 miles W. of Fort Hall: 1907—seventy-seven moths and 340 butterflies, including 1 *T. formosa*, 6 dry-season, 1 intermediate and 18 wet-season *Precis sesamus*, 7 bred *Precis archesia* (2 from eggs found on food-plant, 5 from eggs laid by a parent which escaped), types and paratypes of ♀ forms *cabiroides*, Poulton, and *tenelloides*, Poulton, of *Acraea alicia*, and a remarkable dark variety of ♂ *alicia*, type and paratypes of *A. asboloplintha rubescens*, Trimen, 5 of the E. f. of *A. pharsalus*, a fine series of ♂ and

♀ *Phylaria heritsia* and of *Cupido stellata*. The fine collection from Weithaga also included 7 of the Tachinid parasites (*Blepharipoda* sp.) which emerged from 9 out of 10 pupae of *D. chrysippus*, and an Asilid with its prey, a Muscid fly: 1908—one *Charaxes pollux*: 1909—one moth and 18 butterflies, including 2 ♂ *A. asboloplintha rubescens*: 1911—two *Hesperidae*.

Ngondo River (5,000 ft.), about 6 miles N. of Weithaga: 1909—nine butterflies, including 1 ♀ *Precis westermanni*, 5 ♂ 2 ♀ *Acraea lycoa kenia*, Eltringham.

Matthioya River (about 4,100 ft.), about 15 miles W. of Fort Hall: 1909—one *Pap. leonidas*: 1911—one *Pardopsis punctatissima* (about 5,000 ft.).

Mt. Kenia (6,500 ft.), forest on S.W. slopes of: 1909—six butterflies, including 1 ♂ 1 ♀ *A. asboloplintha rubescens*, 1 *Charaxes eupale*, and 1 *Castalius margaritaceus*: 1911—five butterflies, including 2 *Mycalesis dentata* and 2 *Hesperidae* (about 6,000 ft.).

Embu (about 6,000 ft.), S.E. slopes of Mt. Kenia, cultivated ground: 1911—nine butterflies, including 1 dry-season *Precis sesamus*, 1 *Acraea asboloplintha rubescens*, 2 ♂ 1 ♀ *A. uvui*, 3 *Lachnocnema*.

Near Embu (4,000–4,400 ft.), 30 miles N. of Fort Hall: 1909—ten butterflies, including 1 ♀ *A. asboloplintha rubescens*.

Thiririka River (about 6,000 ft.), S. of Mt. Kenia: 1911—1 pair *Pinacopteryx* (capt. *in cop.*).

Aberdare Mountains (7,500–8,200 ft.), in forest: 1909—2 *Acraea baxteri*, 1 *Mylothris narcissus*.

Kinangop (11,000 ft.), Aberdare Mountains: 1909—1 African f. of *Apis mellifica* and 7 butterflies, including 2 *Acraea excelsior* and 1 white ♀ of *Colias electra*.

Kinangop (about 8,500 ft.), S. side of: 1907—two moths and twenty-five butterflies, including 3 *Brenthis hanningtoni*, 4 *Antanartia abyssinica*, and 2 *A. excelsior*.

Kinangop (8,500 ft.), bamboo forest on S.E. slope of: 1907—nine butterflies.

Kinangop, plain S. of (about 8,500 ft.): 1907—seventeen butterflies, including 10 *Brenthis hanningtoni* and 2 *Acraea excelsior*.

Maragwe River (about 7,000 ft.), about 10 miles E. of Kinangop: 1907—one *Uranothauma nubifer* and 1 *H. abbotti*: 1909—two *Planema quadricolor* and 1 *H. abbotti.*

Dr. Dixey has made the following notes on some of the most interesting species in the fine series of British East African *Pierinae* in the above collection.

Pinacopteryx liliana. A good specimen of the somewhat unusual yellow form of the female.

Pinacopteryx simana. There is a good deal of confusion about this species, which is quite distinct from *P. liliana*, though often mixed up with it in collections. There is no *P. simana* ♀, identified as such, in Coll. Brit. Mus. Godart's type of *P. doxo*, which has been supposed to be identical with *P. venata*, Butl., is probably a pale specimen of *P. simana* ♀.

Teracolus elgonensis. A fine series of a remarkable and not very common species of *Teracolus.*

Teracolus daira. These are of the deeply-marked E. African form, *T. heuglini*, sometimes ranked as a distinct species.

Teracolus celimene. A link between the "purple-tips" of Africa and the black-and-yellow *T. protomedia* of N.E. Africa and Arabia.

Mylothris narcissus. An interesting form of the protected genus *Mylothris.* This species represents *M. trimenia* of S. Africa, and serves as a model for *Phrissura lasti.*

Belenois margaritacea. This species, with the closely-allied *B. raffrayi*, though belonging to the family of "Whites", shows, in the resting position, nothing but a uniform black.

The following relatively small, but important, part of the very fine collection from the Lagos District, presented by W. A. Lamborn, Esq., has been catalogued and incorporated:—

(1) Two families of *Hypolimnas dinarcha,* together with their female parents, captured, March 27 and 29, 1912, in the forest E. of Oni Camp. One family consisted of 76 ♂ and 61 ♀, the other of 26 ♂ and 46 ♀ offspring. There was distinct evidence of the inheritance of certain slight differences between the patterns of the two parents. The precise pupa-cases are

placed beside the 13 individuals of the first family to which they belong. This is the first time that the species has been bred, and the form of the pupa is of much interest, indicating affinity with *H. salmacis* and *monteironis* rather than with *dubia* and *wahlbergi*. The long series of bred females of a species rather rare in collections also establishes the fact that this sex is non-mimetic and the male mimetic on the W. coast, while in Uganda both sexes are mimetic and alike, with a pattern rather different from that of the West, and corresponding to the presence of different Danaine models.

(2) Thirteen families of *Hypolimnas* (*Euralia*) *dubia* and *anthedon*, with their female parents, captured Feb.–June, 1912, in the forest E. of Oni. These families, with the 7 others bred by Mr. Lamborn in the previous year, first proved that *anthedon* and all the forms of *dubia* are a single species with individuals split up into various patterns mimicking four different Danaine species in their locality. Of the 1912 parents 8 were *dubia*, and their offspring as well as those of 3 *anthedon* always included both *anthedon* and *dubia*: the 2 remaining *anthedon* produced *anthedon* only. The numerical proportion as well as the fact that a single ♀ *anthedon* (in 1911) produced only *dubia*, leaves no doubt that *dubia* is dominant and *anthedon* recessive. Although this conclusion seems to be established, some of the results obtained in the course of these experiments appear to be inexplicable under any existing hypothesis. The total number of catalogued specimens, including several pupae, is 787.

(3) Ten families of *Hypolimnas misippus*, of which all the females and a few of the males have been catalogued—262 specimens in all. The females of this species are dimorphic on the W. coast, appearing as the type form *misippus* and the form *inaria*. Mr. Lamborn's results show that *misippus* is dominant, *inaria* recessive, thus confirming the work of the Rev. K. St. Aubyn Rogers on the E. coast (see p. 955).

A complete analysis of the Oni families, to be published at no distant date, will furnish far more detailed information concerning the hereditary relationships than has been as yet obtained in this species.

(4) Six families of Nymphaline butterflies, together with the female parents. The total number of specimens catalogued is 172. The species are *Ergolis actisanes* (one family), *Euphaedra medon* (two), and *Harma* (*Cymothöe*) *theobene* (three). Mr. Lamborn is probably the first naturalist who has succeeded in breeding these species, and it is certainly the first time that complete families with their parent have been seen. *H. theobene* is especially interesting because of the light thrown upon the dimorphism of the females in the Lagos district. Many pupa-cases and larval skins are included.

A valuable series of butterflies from various localities in Sierra Leone, chiefly from the neighbourhood of Freetown, were presented by C. A. Foster, Esq., of the W. African Regiment. Now that the specimens from the West coast of Africa are increasing so rapidly in the University Collection, these Sierra Leone examples with excellent data are most welcome. Of the specimens 147 were captured in 1910 at Regent, about 3 miles S.E. of Freetown. 49 in 1911 in various localities, chiefly Wilberforce, near Regent, and 8 in 1912, chiefly at Mabanta (about 100 ft.), about 50 miles N. of Freetown. These latter include 2 *Hesperidae* probably undescribed. The 1910 series is especially rich in the fine Nymphaline genera *Charaxes* and *Euphaedra* and its allies. The specimens are catalogued under the three years, but it is convenient to acknowledge the collection as a whole under 1912.

Of Dr. Longstaff's fine collection of insects of many Orders from the Sûdan (1912), only the butterflies and the Hymenoptera have been catalogued and incorporated. Some of the groups are still being studied. The series of butterflies contained 782 specimens, of which the following are of much interest:—20 *Danaida chrysippus* of all forms, including 2 *albinus*; 6 *Hypolimnas misippus*, 3 ♀ being of the type form and 1 ♀ intermediate; 77 *Lycaenidae*, including a fine series of *Catochrysops eleusis* and 1 *Hypolycaena philippus*. The great feature of the collection was the large number (641) of *Pierinae*, and especially the species of the genus *Teracolus*, which included the following—*protomedia*, *eris*, *eupompe*, *achine*,

daira, evarne, evippe, phlegyas, evagore, ephyia, liagore, pleione, halimede, chrysonome. The most remarkable single species of Pierine was *Calopieris eulimene.* The series contained 28 examples of this very local species, exceedingly rare in collections.

Dr. Longstaff's fine set of Sûdan Hymenoptera (1912) included 191 Fossores, 51 Diploptera, 162 Anthophila, and 40 Chrysids, all of which have been kindly determined by the Rev. F. D. Morice, M.A., F.E.S., Queen's College.

The following Acraeine butterflies were presented by the Hon. W. Rothschild, F.R.S. :—1 *Acraea moluccana meyeri* from Owgarra, Upper Aroa River, British New Guinea (A. S. Meek) ; also, from Angola and the Congo State,—1 *A. pelopeia,* 2 *penelope,* 1 *servona reversa,* 3 *acrita bellona,* 1 *stenobaea,* 1 *anacreon speciosa.* All these Acraeas were very much wanted in the University Collection.

A *trophonius* female of *Papilio dardanus,* Durban (July 5, 1912), was presented by the captor, G. F. Leigh, Esq., F.E.S. Twenty-seven eggs were laid July 6–7, and the offspring were—2 *hippocoon,* 4 *trophonius,* 1 *leighi,* 9 *cenea,* and 11 males. (Proc. Ent. Soc., 1912, p. cxxxiv.)

A splendid set of 122 *Acraeinae* from Madagascar was presented by M. Charles Oberthür of Rennes. The dates and localities are detailed and precise. This gift, added to M. Oberthür's generous donation in 1911, renders the Hope Collection of Madagascar Acraeas one of the finest in this country. Among the species the following are of special interest—*A. igati, damii, hova* (a ♂ and ♀ of this splendid species—the largest Ethiopian *Acraea*—new to the Collection), *fornax, strattipocles, masamba, sambavae,* and *ranavalona.*

A female specimen of the rare *Acraea igati* (Madagascar) was presented by Herr F. Wichgraf of Berlin.

Two dragon-flies and 81 Lepidoptera from the neighbourhood of Ambatoharanana, Central Madagascar (1907–11), were presented by the captor, Rev. J. U. Yonge, M.A., Keble College. The moths include 7 *Urania rhipheus,* and the butterflies a beautiful example of *Papilio antenor* (Oct. 8, 1907), very rare in the district, and 1 *Acraea damii.*

Ninety-nine butterflies and 11 moths from the Eastern side of Madagascar were also presented by the same kind donor. The majority of these were captured on the journey from Andevoranto to Ambinanindrano, in the neighbourhood of the latter locality, and beyond it on the journey to Ambatoharanana. The series included some fine species very much wanted by the Collection, captured by the Rev. G. K. K. Cornish, M.A., and given by him to the donor:—*Euxanthe madagascariensis*, *Pseudacraea imerina*, *Charaxes ctesipe cacuthis* ♀ (new to the Collection), *Neptis kikideli*, *Salamis anteva*, *Precis eurodoce*, &c. An interesting specimen of *Aterica rabena* with the right forewing shorn has been added to the bionomic collection. The Hope Department is poor in species from Madagascar (except in the *Acraeinae*), and the gift of these specimens with excellent data of time and place is very welcome.

The following butterflies, most of which were greatly wanted by the Department, were presented by J. J. Joicey, Esq., F.E.S. :—

Africa.—2 *Acraea amicitiae* from Toro, Uganda Protectorate (Coll., F. J. Jackson), and 1 *Charaxes antamboulu* from Madagascar. The *Acraea* is new to the Collection.

Oriental Region.—37 butterflies, including 2 from Aru Islands (the Erycinid *Abisara segecia*, new to the Collection), and 24 from New Guinea, mostly from the N. and N.W., collected by C. and F. Pratt. Among the Papuan species are 2 *Acraea meyeri*, 2 *Apaturina*, 1 *Dicallaneura decorata* (an Erycinid new to the Collection), and 19 *Delias*, of which *D. weiskei*, *callima*, *iltis*, *rothschildi*, *bornemanni*, *microsticha*, *fuliginosus*, *emilia*, *kummeri*, *kummeri* var. *ligata*, *niepelti*, *castaneus*, and *aroae* are new to the Collection.

Tropical America.—52 butterflies, including many species of *Catagramma*, *Agrias*, and other *Nymphalinae*, &c., much wanted by the Collection. The localities are chiefly in Ecuador and Peru.

Eighteen Pierine butterflies from New Guinea were presented by Sir George Kenrick, F.E.S. The series includes

8 species of *Delias—bakeri*, *castaneus*, *pratti*, *kummeri* var. *ligata*, *dixeyi*, *ornytion*, *emilia*, and *meeki*, and 2 *Leuciacria acuta*, allied to *Delias*. Nearly the whole of the specimens were collected (1908–10) by C. and F. Pratt in the Arfak Mountains in N.W. New Guinea. This island, which is the metropolis of the interesting genus *Delias*, is very poorly represented in the Hope Department, and the gift of such a fine series of species is a most welcome addition to the collection of *Pierinae*. The whole of the species except *D. ornytion* are new to the University Collection.

The following specimens were presented by the late Herbert Druce, Esq., F.L.S., the kind friend whose recent death has been so great a loss to entomological science. The condition of the specimens as a whole is not good, but the localities and the species represented render the gift of special value.

Alpazacu (3,600 ft.), Rio Pastaza, E. Ecuador: collected by M. G. Palmer.—102 butterflies.

Many localities in E. Ecuador (M. G. Palmer) and one in S. Peru.—2 *Hesperidae*, 40 moths, and 1 Neuropteron.

Many localities in the Philippine Islands (J. J. Mounsey).—67 butterflies and 18 moths.

Dorei Bay, N. New Guinea (1910), collected by C. and F. Pratt, and Upper Setekwa River, Snow Mountains, Dutch New Guinea, 1910, collected by A. S. Meek.—7 butterflies and 1 moth.

Bidi, Sarawak, Borneo (1907–8), collected by C. J. Brooks.—15 moths.

Forty-two butterflies from Concepcion, Province Tucuman, N.W. Argentine (1912), were presented by the captor, C. M. Dammers, Esq. The locality renders the specimens of special interest, for we here meet with tropical forms near the southern boundary of their range. Among the Pierines are a ♂ and ♀ *Tatochila*, which Dr. Dixey refers to a species hitherto undescribed.

Three most interesting series of Hawaiian Wasps collected on three dates in 1912, on the island of Oahu, were presented

by Dr. R. C. L. Perkins, M.A., D.Sc., Jesus College, having been captured by him and J. C. Kershaw, Esq.:—(i) April 26—Makiki, below 400 ft., 38 specimens of *Odynerus nigripennis*: (ii) May 3—Lowlands near coast east of Honolulu, 21 *O. nigripennis* with the following species belonging to the same colour-group—1 *O. montanus*, 2 *iopteryx*, 6 *Nesodynerus rudolphi*; 12 examples, divided among 3 species, of another colour-group, characterized by white bands, were also captured, together with 12, also divided between 3 species, of a third colour-group: (iii) May 10—Palolo, forest, 1,200–1,500 ft., 19 examples and two species of a colour-group characterized by dull red marks on the abdominal segments; of the group resembling *O. nigripennis*, 15 specimens of *Odynerus*, divided between three species, and, with the same colouring, 6 *Crabronidae* (Fossores) divided between 2 species; 5 examples of an Ichneumonid entering the last colour-group were also captured.

The whole of these 137 specimens arranged in their groups and in three divisions, according to date and locality, have been added to the bionomic series. They are of the utmost importance, for they prove that the members of the colour-groups into which the Hawaiian Wasps and their mimics may be divided do actually fly together and may be caught on the same day and in the same place. They also give very safe indications as to the dominant species in the groups. The collection was exhibited at the Entomological Congress, and a complete analysis of the captures is published as a note to Dr. Perkins's paper in the Trans. Ent. Soc., 1912 (p. 682 n.).

A hundred and fifteen butterflies and 17 moths from Stonecutter's Island, Hongkong (1912), were presented by the captor, Capt. R. A. Craig. The island is situated about a mile from the mainland, and it will be of great interest to study the collection in order to ascertain whether any effects of isolation are to be detected in it. The Papilios include an interesting series of 4 ♂ and 6 ♀ s of *P. polytes*. All the ♀ s were of the ♂-like form *cyrus*. The model of the commonest mimetic form of the ♀, the *polytes* f., was entirely wanting from the collection—its absence being accompanied by the

disappearance of its mimic, but not of the species to which the mimetic form belongs. Of the 6 examples of *Precis almana*, one was the wet-season form *asterie* (June, 1912), while 5 were the dry form *almana* (April, October, November).

Six cocoons of the Tineid moth *Epicephala chalybacma* were presented by E. E. Green, Esq., F.E.S., who collected them in his compound at Peradeniya, Ceylon (1912). The specimens illustrate Mr. Green's interesting account of the construction of the cocoon and the arrangement upon it of the spheres secreted by the larva (Proc. Ent. Soc., 1912, p. cvi). Two of the specimens were given to the British Museum of Natural History.

A fine set of 28 Catocalid moths was presented by E. M. Dadd, Esq., F.E.S. The specimens, nearly all of which had been bred, were partly European and partly North American.

One *Camponotus aethiops* and 2 *C. lateralis* from Chigny, Switzerland (August 24, 1912), and 3 *Aphaenogaster subterranea* from Yvorne (August), were presented by the captor, W. C. Crawley, Esq., F.E.S.

Four Odonata (dragonflies) and 2 *Ephemeridae* from Traunsee, Austria (1911), were presented by the captor, H. H. Druce, Esq., F.L.S.

Six butterflies and 111 moths from various localities in the New Forest (1912) were presented to the general collection by the captor, F. C. Woodforde, Esq., B.A., Exeter College. The specimens from these localities, presented to the British collections by the same kind donor, are acknowledged below.

Five examples of *Melitaea aurinia* (1912) captured in North Devon by G. B. Adams, Esq., were also presented by F. C. Woodforde, Esq.

Additions to the British Collections in 1912.

The following collections of several obscure and difficult but most interesting groups of Arthropoda have been presented by R. S. Bagnall, Esq., F.L.S.:—

(1) Very complete collection of British Chilopoda (Centipedes), Symphyla, Pauropoda, Diplopoda (Millipedes), in-

cluding numerous additions to the British fauna and the types of 8 new species of Symphyla.

(2) British Thysanoptera (Thrips), including types of several new species.

(3) British Terrestrial Isopoda (Woodlice), Thysanura (Bristle Tails), Collembola (Spring Tails), Anoplura (Blood-sucking lice), and Mallophaga (Biting or bird-lice), including numerous additions (some not yet recorded) to the British fauna and a few types.

(4) A collection of Thysanoptera from various parts of the world, including numerous types and co-types, is also included in addition to those named above.

Generous help to the British collections has been afforded, as in previous years, by F. C. Woodforde, Esq., B.A., Exeter College. Fine series, presented by the donor, have been already incorporated or are ready for incorporation. The following British localities are represented :—

The New Forest.—115 *Geometridae*, including several *Selidosema ericetaria* (*plumaria*) and *Pachycnemia hippocastanaria*, 185 *Noctuidae*, including several *Leucania turca* and *Panolis piniperda*, 72 Micro-Lepidoptera, 52 insects of several Orders, and 7 Lepidoptera with injuries probably inflicted by birds.

North Cornwall, near Bude (1911–12).—12 *Melitaea aurinia*, bred (May 27–31, 1912) from ova obtained in May, 1911 ; 19 moths, including 2 *Luperina cespitis*, 2 *Dianthoecia barrettii*, 4 *Botys asinalis*, 2 *Stilbia anomala*; also 6 *Carabus violaceus*, var. *exasperatus*, and 20 *C. catenulatus*, taken at sugar (July, 1910).

South Devon. Starcross.—7 *Callimorpha hera*, bred (July, 1912) from ova obtained Aug., 1911.

Abingdon.—12 *Melitaea aurinia*, bred (June, 1912).

Sutton Coldfield Park, near Birmingham, 1911.—5 specimens of the Crambid moth *Phycis fusca*.

Nineteen examples of *M. aurinia* captured, 1912, in North Devon by G. B. Adams, Esq., together with 4 examples of *Tapinostola extrema* (*concolor*) captured, 1912, in Huntingdon-

shire by — Temple, Esq., were also presented by F. C. Woodforde, Esq.

Thirty-seven examples of *Chrysophanus phlaeas*, taken on the same bank at Cerne Abbas, Dorset, in the hot August of 1911 and in the cold August of 1912, were presented by the captor, Dr. R. C. L. Perkins, M.A., D.Sc., Jesus College. Of the fourteen 1911 males 8 were dark and 6 intermediate, while the eight 1912 males were all bright; the seven 1911 females were less bright than the eight 1912 females (Proc. Ent. Soc., 1912, cxxxviii). It is very interesting that the exceedingly hot summer of 1911 should have thus reproduced in this country the Southern European form of *phlaeas*, which is well known to be darker than that of the North. It is particularly interesting that the specimens should have been taken in the two years in precisely the same locality.

A very interesting collection of beetles, taken Apr. 26–May 1, 1912, in Tiree, the most south-westerly of the Inner Hebrides, was presented by the captor, H. Donisthorpe, Esq. The series includes 280 pinned specimens or cards of specimens, the latter being numerous and well filled. These beetles have been the subject of an interesting paper by W. E. Sharpe, F.E.S., in the *Entomologist's Record*, 1913, xxv, pp. 19–23. The author argues that some of the species probably date back to the time when Tiree was continuous with the mainland.

A ♀ of the fine Tipulid fly *Pachyrrhina crocata* from Tubney, near Oxford, was presented by the captor, Mr. Joseph Collins, of the Hope Department, together with the Braconids *Caelinus niger* and *Pezomachus fasciatus* from the same locality. The latter was captured in the net with an example of the ant *Myrmica laevinodis* (Sept. 15). These two insects, which bore a very close resemblance to each other, have been added to the bionomic collection.

Two examples of the fly *Gastrophilus equi*, from the Great Hangman, Coombe Martin, N. Devon (Sept.), were presented by the captor, Dr. G. B. Longstaff.

Six examples of *Tortrix pronubana*, bred 1912, from the Bournemouth district, were presented by W. Claxton, Esq.

Three examples (1907) and 8 (1910) of *Hesperia lineola*, from Sheppey, were presented by the captor, Commander J. J. Walker, Hon. M.A., F.L.S., F.E.S. Four *Clisiocampa castrensis*, bred 1912 from larvae found and reared as in 1911 (see p. 954), were presented by the same kind friend of the Department, together with the female parent of *Nemeophila russula* and 5 of its offspring (3 ♂, 2 ♀). The parent was captured June 19, 1912, in the Blean woods, Kent; the larvae, fed upon lettuce, spun cocoons at the end of August and emerged at the end of September.

One *Formica fusca*, race *picea*, from the New Forest (July), was presented by the captor, W. C. Crawley, Esq., B.A., F.E.S., Worcester College, together with 2 examples of *Anergates atratulus* and 1 of *Tetramorium caespitum*, in whose nest they were found. The recent discovery of *Anergates* in this country in the New Forest is of the highest interest.

The following extremely rare and interesting British birds were presented by F. C. Woodforde, Esq., B.A., Exeter College:—Kite, adult male; Honey Buzzard, adult male; Marsh Harrier, adult male and female; Common Buzzard, var., adult female; Buff-breasted Sandpiper, immature, autumn; Bartram's Sandpiper, adult; Marsh Warbler, adult male and female and two eggs; Sea Eagle, immature; Osprey, male, nearly adult.

The Hope Library.

Mr. R. S. Bagnall, although unfortunately prevented from beginning his work as Assistant Curator in succession to the late R. Shelford, M.A., has during many visits to Oxford given much kind and efficient assistance to the Department and especially to the Hope Library. The following list of the accessions in 1912 is mainly due to his kind help.

Donations.

The following publications and Reports were presented:—

Bombay Natural History Society: the publications for 1912.

British Museum, Trustees of the:—

Catalogue of the Lepidoptera Phalaenae in the British Museum, vol. xi, with Supplementary volume of plates CLXXIV—CXCI, by Sir George F. Hampson.

A Revision of the Ichneumonidae, based on the Collection in the British Museum, pt. 1, by Claude Morley.

Cambridge University: Forty-sixth Annual Report of the Museum and Lecture-Rooms Syndicate (for 1911).

Carnegie Institute of Washington, Department of Experimental Evolution: Annual Report of the Director for 1910.

Colombo Museum, Ceylon: Spolia Zeylanica, vol. viii, pts. xxix, xxx and xxxi.

Entomological Research Committee: Correspondence relating to the Development of Entomological Research in the British Colonies and Protectorates. (Presented to Parliament by Command of His Majesty.) Nov. 1912.

Indian Museum, Calcutta, Records of: Index, vol. ii; vol. iii, pts. i–iv, and index; vol. iv, pts. i–v; vol. v, pts. i–iv; Memoirs, i, no. 4, and index; ii, nos. i–iv; iii, no. 1.

Annual Report, 1908–9.—Annotated list of the Asiatic Beetles in the Collection of the Indian Museum, pt. i, by N. Annandale and Walter Horn. Rules, pt. i.

Instituto Oswaldo Cruz, Rio de Janeiro: Memorias, vol. i, pts. i and ii; vol. ii, pt. ii; vol. iii, pt. ii; vol. iv, pt. i.

London: Local Government Board Report (New Series, No. 66): Further Reports (No. 5) on Flies as Carriers of Infection, 1912.

Maine, University of: Agricultural Experiment Station, Orono. Five Bulletins.

Manchester Museum: Report on the Zoological Department. Session 1909–10.

Marine Biological Association of the United Kingdom: Journal, n.s., ix, no. 3, 1912.

New Jersey, Agricultural Experiment Stations: Papers, No. 242, by Dr. B. H. A. Groth, Ph.D. (1912); and No. 245, by Byron D. Halstead (1912).

New York State Museum: Educational Department Bulletin. Museum Bulletin, 136 (Albany, 1910); 141 (Albany, 1910).

Ottawa: Experimental Farms of Canada: three Reports for 1898, 1911, and three Separata from the forty-second Annual Report of the Entomological Society of Ontario, 1911; Bulletin No. 66 of the Central Experimental Farms, 1910; Division of Entomology, Bulletins, Nos. 2, 3, 4 and 5, 1912.

Six papers, including Farming in Canada, 1908. Report of Scottish Agricultural Commission (Edinburgh and London, 1909).

Pennsylvania, University of: Contributions from the Zoological Laboratory, 1912, vol. xvii.

Philadelphia: The Academy of Natural Sciences of Philadelphia, vol. xv, Second Series.

Radcliffe Library: Catalogue of Books added to the Library in 1911.

Rhodesia, Agricultural Department: *Rhodesian Agricultural Journal*, Oct. 1905.

Rhodesian Museum, Bulawayo: Tenth Annual Report (1911).

Royal College of Surgeons: Annual Museum Report, 1912.

Sarawak Museum: Report for 1911; Journal, vol. i, Nos. 1–2, 1911–12.

Smithsonian Institution, Washington: Memoirs by the following authors:—INSECTA. T. D. A. Cockerell (2 memoirs), J. C. Crawford (2), Harrison G. Dyar, H. T. Fernald, J. R. Malloch, W. D. Pierce, J. A. G. Rehn, S. A. Rohwer (2), C. H. T. Townsend, H. L. Veireck (2), C. B. Wilson. CRUSTACEA. W. T. Calman, G. D. Marsh, A. S. Pearce, H. A. Pilsbry, Harriet Richardson (9), C. B. Wilson.

United States Department of Agriculture, Bureau of Entomology: Publications for 1912:—A special publication on the Mexican Cotton Boll Weevil; 27 Bulletins and

indices for Bulletins 80, 82, 90 and 91; 20 Circulars; Technical Series, 9 separata, and 5 Farmers' Bulletins. The publications include an important paper on Life History and Bionomics of N. American Ticks, by W. A. Hooker, F. C. Bishopp, and H. P. Wood; The Behaviour of the Honey Bee in Pollen Collecting, by Prof. D. B. Casteel, Ph.D. (Washington, 1912); Results of the Artificial Use of the White-Fungus Disease in Kansas, by Prof. F. H. Billings and Prof. P. A. Glenn (Washington, 1911); Calosoma Sycophanta, by A. F. Burgess (Washington, 1911).

The following authors have presented their publications to the Library:—

R. S. Bagnall: A valuable series of 5 papers on Thysanoptera (including "Thysanoptera" in the "Fauna Hawaiiensis", Cambridge, Dec. 1910), 1 on Protura, 1 on Crustacea, 1 on Symphyla and 1 on Myriopoda, together with memoirs by the following authors:—20 papers on Crustacea, including 3 valuable 4to monographs (20 plates), by Dr. H. J. Hansen, and several important papers and monographs by Prof. G. S. Brady, F.R.S., Rev. T. R. R. Stebbing, F.R.S., Dr. W. M. Tattersal, Dr. W. T. Calman, E. G. Racovitza and Alex. Patience; 5 papers on Lepidoptera (4 by Dr. T. A. Chapman and 1 by H. S. Leigh), Sharp and Fowler's Cat. of British Coleoptera, and R. South's Syn. List of British Lepidoptera; 2 papers on Thysanoptera by R. Coesfeld and Dr. H. Uzel respectively.

Nathan Banks: Thirty-three papers on Insecta (Hymenoptera, Neuroptera, Hemiptera, Diptera) and Arachnida, including Catalogue of Nearctic Spiders (Washington, 1910).

E. Brunetti: The Fauna of British India, Diptera Nematocera (excluding *Chironomidae* and *Culicidae*).

Malcolm Burr, M.A., D.Sc., New College: Six papers chiefly on Dermaptera.

H. Eltringham, M.A., F.Z.S., F.E.S., New College: a bound and interleaved copy of his monograph of the genus *Acraea*, 1911. Mr. Eltringham kindly proposes to enter in this volume any additional facts that may be discovered or

corrections that require to be made with the progress of knowledge.

T. Bainbrigge Fletcher, R.N., F.E.S., Director of the Agric. Coll. and Res. Inst., Coimbatore, Madras: Twenty-three papers, chiefly on *Orneodidae* and *Pterophoridae* and on Economic Entomology, including "The *Orneodidae* and *Pterophoridae* of the Seychelles Expedition" and "Lepidoptera exclusive of the *Tortricidae* and *Tineidae*" (Percy Sladen Trust Exped. to the Indian Ocean in 1905, Trans. Linn. Soc., London); together with a paper on Ceylonese *Tetriginae*, by J. L. Hancock, and Bulletins Nos. 23 and 29 of the Agricultural Research Institute, Pusa, 1912.

Prof. F. Hermann, of Erlangen: Monograph of the *Asilidae* in Beitr. zur Kenntnis der Süd-Amerikanischen Dipterenfauna (Abh. der Kaiserl. Leop.-Carol. Deutschen Akad. der Naturforscher, xcvi).

J. Douglas Hood: Eight papers on the Thysanoptera of North America.

Prof. A. D. Imms: Two papers including one on Collembola from India, Burma, and Ceylon.

Prof. Aug. Lameere: Revision des Prionides (Mémoires 1–20).

G. B. Longstaff, M.A., D.M., F.R.C.P., New College: "Butterfly Hunting in Many Lands", London, 1912; subsequently a second copy with the index revised, and 2 papers from the "Entomologist's Monthly Magazine", together with Vol. *Amathusiidae* of "Das Tierreich" by H. Stichel, Berlin, 1912, and a paper on Mimicry in Boreal American Rhopalocera by Dr. Hy. Skinner.

J. C. Moulton, B.Sc., Magdalen College. A list of the Butterflies of Borneo.

Rev. Father R. P. Longinos Navás, S. J.: Four papers on Neuroptera.

M. Charles Oberthür: Études de Lépidoptérologie Comparée. Fascicule vi. Rennes, 1912. This splendid volume (pp. 1–355) is illustrated by the most exquisitely coloured Plates, numbered xcvii–clx, as well as by many reproductions of photographs.

W. Schaus: Eight papers on Neotropical Lepidoptera.

Hugh Scott, M.A.: Two papers including Coleoptera (*Lamellicornia* and *Adephaga*) in the Percy Sladen Trust Expedition to the Indian Ocean in 1905. (Trans. Linn. Soc., London, XV, pt. 2.)

Rev. T. R. R. Stebbing, M.A., F.R.S., Worcester College: The Sympoda (Part VI of S. A. Crustacea for the Marine Investigations in South Africa). (Ann. S. A. Museum, Vol. X.)

Prof. Fred V. Theobald: Ten papers chiefly dealing with the *Culicidae* and British Aphids, together with one paper on *Culicidae* by E. H. Strickland.

Dr. Ivar Trägärdh: A valuable set of 22 papers chiefly dealing with the *Acaridae* (including certain Myriopodophilous forms), including the report on the *Acari* in the Results of the Swedish Zoological Expedition to Egypt and the White Nile, 1901, and the *Acari* of the Swedish South Polar Expedition.

Rowland E. Turner, F.E.S.: Five papers on Fossorial Hymenoptera.

A. O. Walker: Sixteen papers on Crustacea including Amphipoda Hyperiidea of the "Sea Lark" Expedition, and Amphipoda Gammaridea from the Indian Ocean, British East Africa, and the Red Sea (Percy Sladen Trust Expedition to the Indian Ocean in 1905, Trans. Linn. Soc., London); *Amphipoda* in the Report on the Pearl Oyster Fisheries of the Gulf of Manaos, and Amphipoda in the National Antarctic Expedition, Vol. III.

Rev. Father Eric Wasmann, S.J.: A valuable series of sixteen papers on Myrmecophilous and Termitophilous forms and their hosts, published 1905–10, including "Zur Kenntniss der Ameisen und Ameisengäste von Luxemburg", in three parts, Die psychischen Fähigkeiten der Ameisen, Stuttgart, 1909.

Original papers have also been presented by the following authors: W. G. Allee (Bionomic); Prof. T. Hudson Beare; the late Col. C. T. Bingham (2 memoirs); Dr. Ignacio Bolivar and C. Ferrière; A. E. Cameron; Prof. G. H. Carpenter

(2 memoirs, one in conjunction with Mabel C. MacDowell); Dr. Alfons Dampf; A. d'Orchymont (2 memoirs); Herbert Druce; Richard Ebner (2 memoirs); J. A. Gilruth (2 memoirs, one in conjunction with Dr. Georgina Sweet); E. Ernest Green (2 memoirs); C. Gordon Hewitt, D.Sc., Dominion Entomologist, Ottawa (2 memoirs); P. H. Grimshaw; J. C. Kershaw (2 memoirs); Frederick Knab (15 short memoirs and notes); Joseph Mangan; G. Meade-Waldo; F. Merrifield; E. Meyrick, F.R.S.; F. Muir and J. C. Kershaw (2 memoirs); E. Olivier (2 memoirs); E. F. Phillips; H. Rowland-Brown (2 memoirs bound in one); Victor E. Shelford (3 memoirs, Bionomic, and 1 review); Dr. Yngve Sjöstedt (2 memoirs); H. Viehmeyer (Ameisen aus Deutsch-Neuguinea); Rev. Jas. Waterston; J. Henry Watson; Dr. Creighton Wellman.

Valuable additions to the Library have also been presented by the following donors :—

Mrs. P. B. Mason : Manuscript Vol. Novitates Staintonianae, with coloured figures, 1842. This interesting and valuable manuscript belonged to the library of the late P. B. Mason, F.E.S.; Mr. C. O. Waterhouse very kindly suggested the Hope Library to the donor.

F. Merrifield, F.E.S.: A copy of "African Mimetic Butterflies", Oxford, 1910, by H. Eltringham.

G. A. James Rothney, F.E.S.: Two papers on Ants, by H. Donisthorpe, F.E.S.; Ent. Soc. Trans., 2 vols., 1910–11, bound uniformly with the series already given by the generous donor; Ants and their Ways, by Farren White; The Malay Archipelago, by A. R. Wallace, 1872; The Naturalist on the Amazon, in 2 vols., by H. W. Bates, 1863 (original edition); Travels amongst the Great Andes of the Equator, Ed. Whymper, 1892, and Supplement, 1891; The Humble Bee, by F. W. L. Sladen, 1 vol., 1912.

Hon. Walter Rothschild, F.R.S.: The parts of the Novitates Zoologicae of the Tring Zoological Museum published in the year 1912.

R. Shelford, M.A., F.Z.S., F.E.S.: The following memoirs presented by the late R. Shelford in 1911 were accidentally omitted from the Report of that year:—12 separata, chiefly dealing with Orthoptera and Coleoptera (*Hispidae*), by Ermanno Giglio-Tos, R. Gestro, and Achille Griffini, and including Dr. H. Schubotz's report of the German Central-African Expedition of 1907–8.

Miss Shelford: 43 separata, originally belonging to the late Assistant Curator, have been kindly presented by his sister. The series includes 5 papers by the late R. Shelford (pub. 1911–12) and others by Burr (Dermaptera), Griffini (*Gryllacridae*), Shiraki (Phasmids and Mantids of Japan), Handlirsch (Fossil Insects), Froggatt (Economic), V. E. Shelford (Bionomic), and 10 mem. of the U. S. Dept. Agriculture.

Separata on the important subject of Nomenclature, from the First Internat. Congr. Ent. (Brussels, 1912) and the Entomological News, have also been presented to the library.

The Professor:

The publications of the Société Entomologique de France for 1912; and of the Société Entomologique de Belgique for 1912; the publications of the Linnean Society for 1912; the Transactions of the Entomological Society of London for 1912; the Journal of Economic Biology, 1912; Boletín XII (1912) de la Real Sociedad Española de Historia Natural; Bulletin of Entomological Research, vol. i, pts. 1, 2, and 3, vol. iii, pts. 1–3; Lancashire and Cheshire Entomological Society, Annual Report for 1911; Festschrift Herrn Prof. Dr. J. A. Palmén, Helsingfors, gewidmet vols. i and ii.

Exchanges.

The parts of the following journals for the year 1912 were received in exchange for the Hope Reports:—

Deutsche Entomologische National-Bibliothek.

Deutsche Entomologische Zeitschrift.

Entomologisk Tidskrift, Stockholm.

Bulletin de la Société Entomologique Suisse.

PURCHASES.

The following publications of the year 1912 were purchased for the Department:—The volume of the Ray Society, of the Zoological Record, the numbers of the Entomologist's Monthly Magazine, the Entomologist, and the Entomologist's Record.

In addition to these regular purchases there were also bought:—The parts issued in 1912 of Lepidopterorum Catalogus, Wagner, Berlin; and a second-hand copy of Rhopalocera Aethiopica, by Prof. Chr. Aurivillius, Stockholm, 1898.

E. B. POULTON.